CIVIL ENGINEERING

JULY 1951

THE MAGAZINE OF CONSTRUCTION

1212 FT. RADIO TRANSMISSION TOWER
THULE AIR BASE — MAJ. GEN. S. D. STURGIS

CONTENTS . . . page 3

...Raymond Features!

NUMBER ONE OF A SERIES

Raymond Piles maintain driving resistance

The steel shell of each Raymond pile retains the resistance developed in driving and protects the fresh concrete from distortion and from mixture with the surrounding soil. The heavy taper of the shell, with its wedge-like effect, usually results in a shorter pile per ton of load carried than straight-sided piles or those with less taper.

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Raymond Concrete Pile Co.

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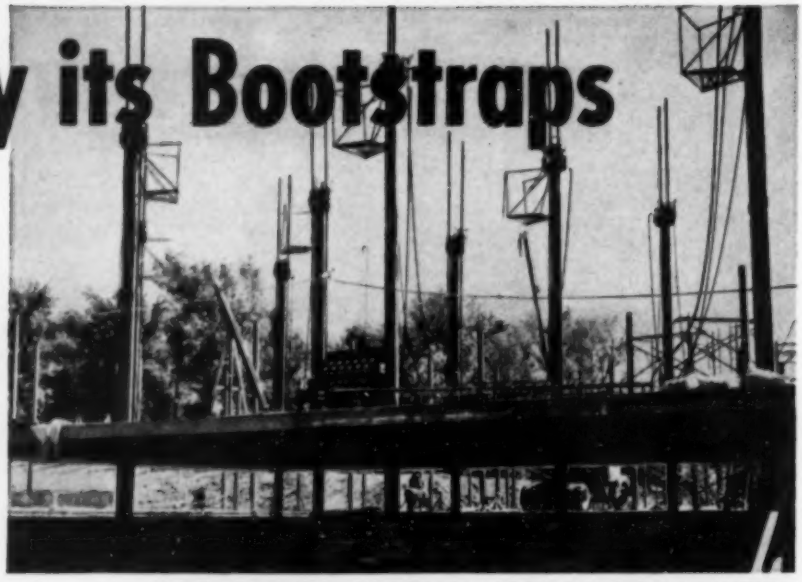
Raised by its Bootstraps

New Hallmark Greeting Card Factory Building Constructed by Lift-Slab Method

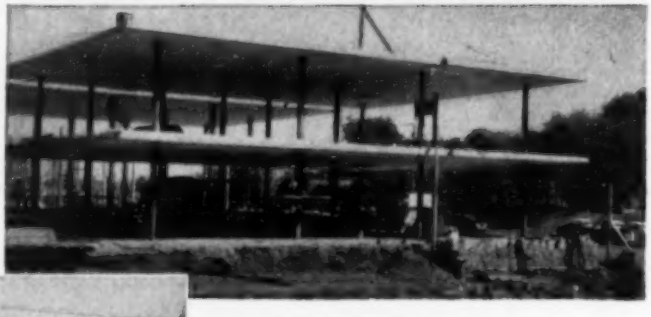


● More than two million greeting cards a day leave the Hallmark production lines—cards distinguished in design and execution, characteristics which have their counterpart in Hallmark's new branch factory building, near Kansas City.

Utilizing the Youtz-Slick Lift-Slab Method, concrete slabs were poured on the main floor, one on top of the other, then lifted into place by hydraulic hoisting equipment, with jacks operated automatically from a control panel. After slabs reached design elevation, steel blocks were welded to columns to support the slabs. And it is quality construction throughout—concreted with Lone Star, hallmark of quality.

Next thing to lifting a building by its bootstraps, the Lift-Slab method saves substantially on forms, eliminates shoring, minimizes material-hoisting costs. For further economy, concrete the last slab with 'Incor'* 24-Hour Cement—start lifting 2 or 3 days sooner.

*Reg. U.S. Pat. Off.



HALLMARK CARDS—Factory Building
Westwood Branch, Johnson County, Kansas

Architects-Engineers:
WELTON BECKET AND ASSOCIATES, Los Angeles, Cal.

General Contractor:
LONG CONSTRUCTION COMPANY, Kansas City, Mo.

Ready-mix Lone Star Concrete:
CONCRETE MATERIALS, INC., Kansas City, Kansas
STEWART SAND & MATERIAL COMPANY,
Kansas City, Missouri

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CIVIL ENGINEERING

JUNE 1954

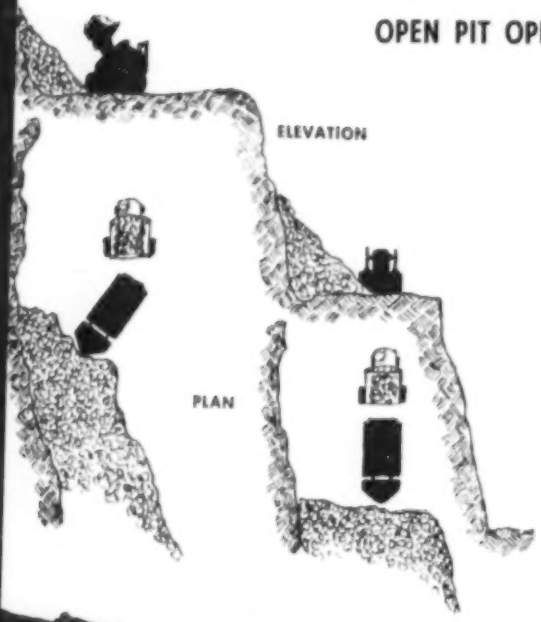
THE MAGAZINE OF ENGINEERED CONSTRUCTION

• **CONTENTS** • **VOLUME 24** • **NUMBER 6**

EIMCO

WORLD'S FINEST TRACTOR-EXCAVATOR

OPEN PIT OPERATIONS INCREASE PRODUCTION WITH SMALL INVESTMENT



Eimco 105 tractors with excavating RockerShovel attachment are being used in open pit mining with extraordinary results:

Loading time 6 yd. truck ..... 45-50 secs.

Average payload per truck ..... 10 tons

Based on 50 min. hr. and half minute switching time for trucks average hourly production..... 400 tons

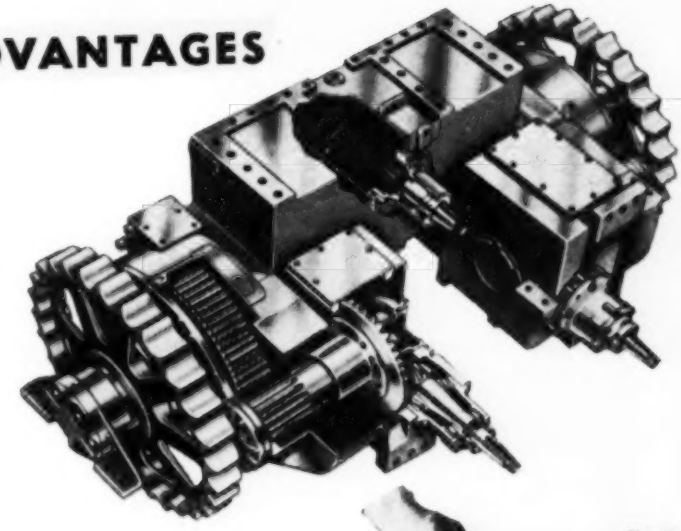
Exceptional loading in many operations has shown even greater tonnage figures where material handled was from stock pile and haulage traffic was not confined to narrow roadways such as encountered in benches of open pit systems.

Eimco 105's are in use by contractors in tunnels and on new construction, rock quarries, underground mining, steel mills and on many other jobs. Where speed and dependability are essential the 105 has proved to be the most rugged piece of equipment ever used.

The exceptional features of the 105 make it the finest piece of equipment of its type ever produced. The Unidrive transmission which contains all clutches and gearing for instant reversal, independent track control and gear changing without stopping are indicative of the new approach to heavy prime moving equipment.

The Eimco 105 final drive is another important design feature. The final drive unit (shown right) is composed of two separate units each of which is driven entirely independently of the other or the one may be driven in reverse of the other.

WITH COST SAVING ADVANTAGES



These final drives are each powered through matched pinion, ring gear sets through heavy, short shafts, husky pinions and gears. Even the short shafts are heavier in construction and larger in diameter than similar shafts used in any large tractor on the makert today. Shafts roll in Timken bearings that are separately caged for easy access, perfect alignment and long life. All clutches and brakes in final drive are eliminated. Gear cases are heavy alloy cast steel. Sprockets, gears and other parts are specially heat-treated for long service life.

Additional exclusive featuers include full oscillating tracks even with the excavator attachment. Easy simple controls, torque converter drive, full visibility with operator up front, all steel construction, clutches that never need adjustment.

These are the unique features that make the 105 the most maneuverable heavy tractor on the market.

We invite you to see, operate and compare the 105 with any other crawler prime mover. Write for information to The Eimco Corporation, P. O. Box 300, Salt Lake City, Utah, or to any Eimco branch.

The bevel gear on the final drive pinion shaft. This is an example of the husky construction of all 105 parts.

Loading trucks on the pit bench. 105's maneuverability permits trucks to stay in close.

Huge boulders are pushed over side by 105 with excavator attachment.

The 105 picks up and loads larger pieces than can be handled by 1½-2 yard conventional shovels.

105 picks up load and waits for truck to position itself then —

A pull on the lever and over it goes. Heavy duty trucks can be loaded fast, with the bucket in high.

Less rugged equipment can be loaded easily with the bucket in low speed.

THE EIMCO CORPORATION

Export Offices: Eimco Bldg., 52 South St., New York City • Salt Lake City, Utah—U.S.A.

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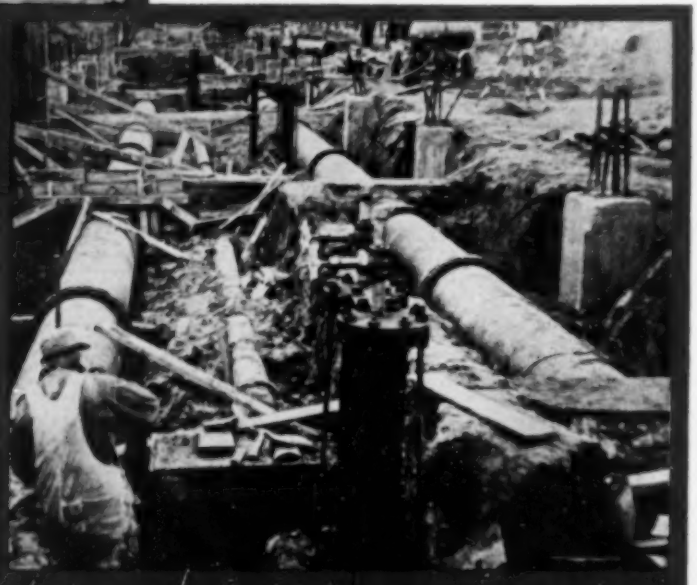
B-40

Used on jobs

When an installation, once completed, should be as trouble-proof as planning and materials can make it—engineers rely on cast iron pipe. It has high beam-strength, compressive-strength and shock-strength. Its effective resistance to corrosion ensures long life, underground or underwater. These are reasons why cast iron pipe is so widely used for water lines in tough terrain, pressure and outfall sewers, river crossings, and encased piping in sewage treatment and water filtration plants. For further information write: Cast Iron Pipe Research Association, Thos. F. Wolfe, Managing Director, 122 So. Michigan Ave., Chicago 3, Ill.



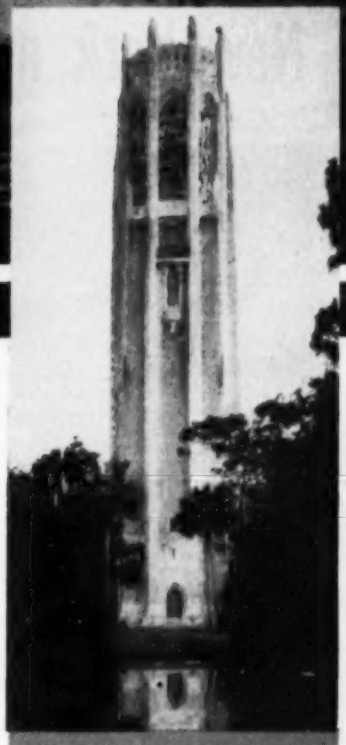
(above)
Cast iron mechanical joint pipe installed in connection with a new, larger sewage treatment plant at Rochester, Minn.

(at right)
Installing cast iron mechanical joint pipe used in air-conditioning system for Northland Shopping Center, Detroit, Mich.

CAST IRON PIPE

Sunshine State Skyscraper

The modern 22-story South-Central Home Office Building of the Prudential Insurance Company of America, highest office building in Florida, will dominate the skyline of fast-growing Jacksonville.
Architects: Kemp, Bunch & Jackson.
General Contractor: Daniel Construction Company.



Bok Tower

The famous Bok Singing Tower at Lake Wales, Florida, is one of the nation's notable beauty spots—a spire created for endless inspiration, placed in a magnificent floral background.

TWO HIGHS for Ingalls in Florida

Entirely different problems with one dependable source of solution. That's the story of *Ingalls* construction in these two magnificent Florida structures. Adaptability has always been a keystone of *Ingalls* service; it is amply illustrated here. Whatever your special construction problem may be, make certain to *see Ingalls first* for your own new high in building satisfaction.

FOR COMPLETE INFORMATION WRITE INGALLS

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Laying the hot-mix Texaco Asphaltic Concrete wearing surface, final step in this New York State highway project. Prime contractor—Tuckahoe Construction Co., Tuckahoe, N.Y.; Asphalt contractor—County Asphalt, Inc., Tarrytown, N.Y.

New York made this an all-flexible highway

Applying an 85/100 penetration Texaco asphalt to the top 4 inches of the 12-inch broken stone base.

A section of the new 22-foot pavement, which will have a 10-foot shoulder on each side when completed.

West of Liberty, N. Y., State Route 52 serves one of New York State's most popular resort areas. Last year, when the Department of Public Works built a new 7-mile link in this highway, it employed flexible construction from top to bottom.

For the sub-base, run-of-bank gravel was laid in two lifts to a compacted thickness of 12 inches. This was covered by three 4-inch courses of broken stone, the top course penetrated by an application of two gallons of 85/100 penetration Texaco asphalt per square yard. A two-course hot-mix Texaco Asphaltic Concrete pavement, with a combined thickness of 3 inches, completed the highway.

The all-flexible type of construction used on New York's Route 52 merits serious consideration for all toll roads, important highways and other heavily traveled thoroughfares. It is capable of absorbing punishing impact for years with a minimum of maintenance. Its first cost and upkeep cost are lower than for comparable pavements. Its easy-riding, skid-resistant qualities, as well as its freedom from glare and absence of joints all contribute to maximum driving comfort and safety.

Helpful information on all types of Texaco asphalt construction for streets and highways is supplied in two booklets, which our nearest office will be glad to send you.

THE TEXAS COMPANY, Asphalt Sales Dept., 135 E. 42nd Street, New York City 17

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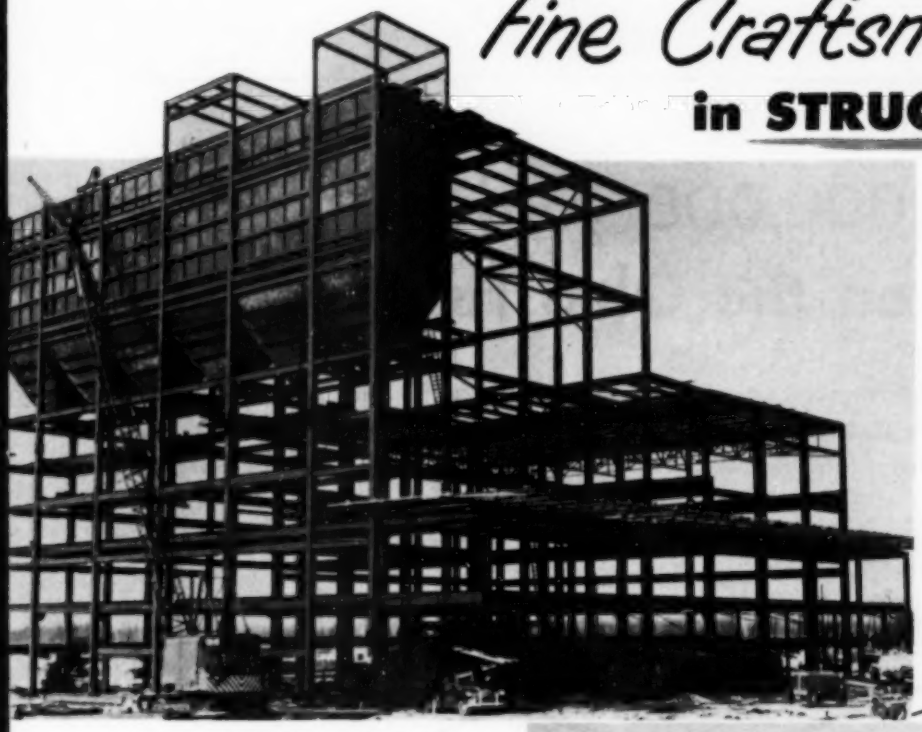

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Richmond, Ind.

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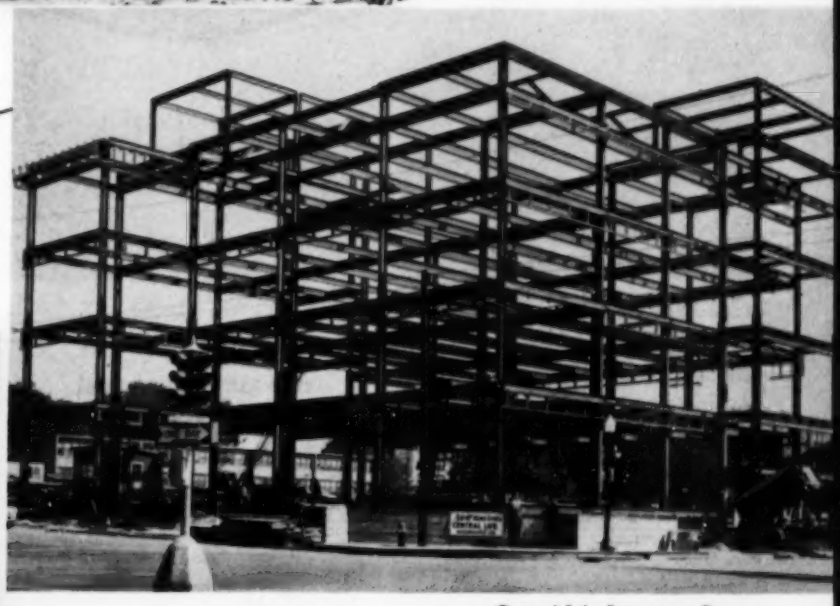
Coast to Coast...



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LOS ANGELES (48).....6399 Wilshire Blvd.	SANTA CLARA, CAL.....677 Alviso Road

Speeding 4,000,000 yards of excavation on the Ohio Turnpike

A fleet of Caterpillar-built machines and engines is moving the total excavation on contract sections C-56, 57, 58, 59 of the nation's newest turnpike project. One overpass doesn't make a turnpike, but it helps explain how V. N. Holderman & Sons, Inc., is doing this big job.

NEAR the western end of the 241-mile Ohio Turnpike, big yellow machines and Caterpillar* Engines are rushing to completion an important 14-mile section. The contract—approximately $10,250,000—was won by V. N. Holderman & Sons, Inc., Columbus.

Among other things, it calls for moving 4,000,000 yards, nearly all borrow. Total borrow for the entire Turnpike is 30,500,000 yards, so Holderman is moving more than 10 per cent of the total.

To do this big job quickly, the contractor has called on a fleet of Caterpillar equipment—four DW20s, four DW-21s, 18 D8s, three D7s, four No. 12 Motor Graders, three No. 80 Scrapers, and three Cat* Diesel Engines to power a Sierra loader, a Lima crane and a Bucyrus-Erie dragline.

One job—an overpass—in section C-56 illustrates how Holderman is using Caterpillar teamwork to do the job. Near the overpass site a Bucyrus-Erie dragline with a 2¼-yard bucket powered by a seven-year-old D17000 Diesel, is changing the channel of a stream to run into a box culvert. Extent of repairs on this hard-working engine: one fuel pump. Not far away a D318 is powering a Lima crane unloading steel for the bridge.

THIS RECORD OF DW20s IS SPEEDING THE DAY		WHEN THE TURNPIKE WILL SAVE MOTORISTS
Workdays	6 per week	1 hr. 27 min. between Cleveland-Toledo
Hours per day	9 hours	1 hr. 43 min. between Cleveland-Pittsburgh
Round trip	1.8 miles	1 hr. 27 min. between Cleveland-Detroit
Load per trip	20 yards	2 hr. 4 min. between Youngstown-Toledo
Loading time	35 seconds	1 hr. 3 min. between Toledo-Akron
Time per round trip	6⅕ minutes	3 hr. 23 min. between Pennsylvania-Indiana borders

A Sierra loader, powered by a D318 Engine and pulled by a D8, is loading three No. 20 Scrapers pulled by DW20s, with the round-trip record above. The units are unloading at the overpass where a No. 12 Motor Grader is grading, a D8 equipped with a No. 8A Bulldozer is leveling, and a D7 is pulling two sheepsfoot tampers.

And in the borrow pit a D8 Tractor

LOADING TIME 35 SECONDS – and it's an all-Caterpillar performance! Loading a DW20 Scraper is a Sierra loader pulled by a D8 and powered by a D318 Engine.

CHANGING CHANNEL to run into a box culvert at the overpass is this 2¼-yard dragline powered by a D17000 Engine.

AS A FAST-MOVING DW20 spreads, a variety of Caterpillar equipment moves into place ready to go into action.

A VERSATILE NO. 12 MOTOR GRADER quickly begins to grade the approach to the Turnpike overpass.

is push-loading three DW21s for spreading on the Turnpike near the bridge.

This fast, efficient, smooth-running Caterpillar combination is one reason that the Turnpike expects to be open to traffic by October 1, 1955. Holderman & Sons, like so many contractors, knows the many advantages of standardizing on Caterpillar equipment for profit-building performance.

Many engine parts are interchangeable, cutting down tremendously on the parts inventory. Operators and mechanics learn one make of machinery, and can get the most work out of it. And, most important, you get quick, efficient one-stop service from one dealer.

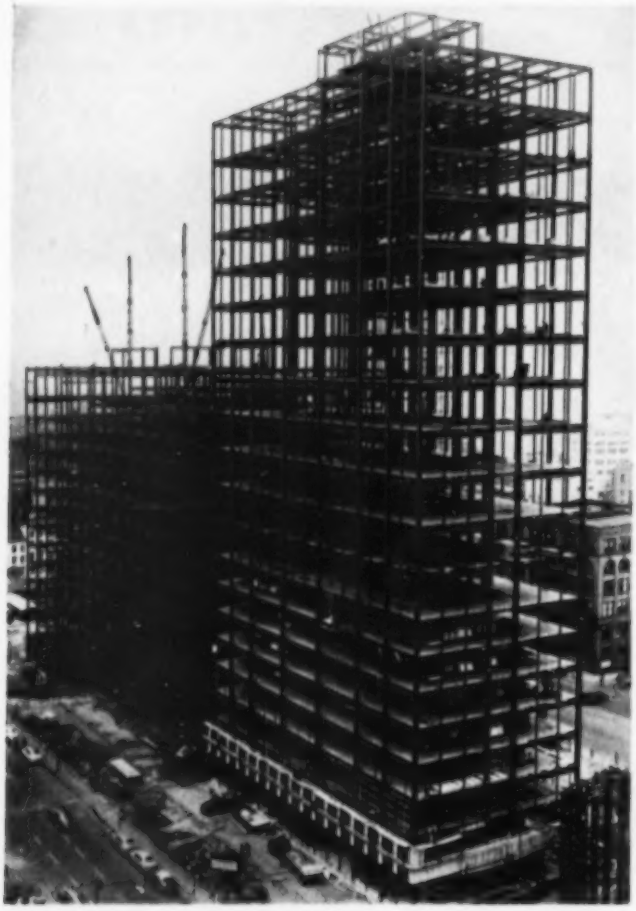
So follow the lead of road-building leaders. Be wise and standardize on Caterpillar equipment.

AND A D8 WITH NO. 8A 'DOZER is on the job leveling as quickly as the borrow is spread by the DW20s.

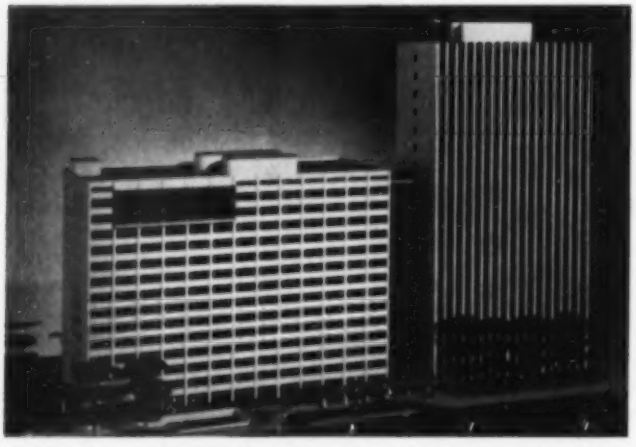
TWO-SECTION SHEEPSFOOT TAMPER follows up the leveling operation. Pulling is a D7 with No. 7A 'Dozer.

CATERPILLAR TRACTOR CO., PEORIA, ILLINOIS, U. S. A.

*Both Cat and Caterpillar are registered trademarks – ®



An important step in Detroit's broad civic-development program, this $26-million structure will house 36 courts in the 20-story Courts Unit, will furnish 28,820 square feet of floor space in the 14-story Office Unit. Owner: Detroit-Wayne (County) Joint Building Authority. *Architects and Engineers:* Harley, Ellington and Day, Inc. *General Contractor:* Bryant & Detwiler Co. *Steel Fabrication and Erection:* Bethlehem Steel Co.



Model of the two units, joined by a 14-story, 38 x 40-ft glassed-in link, which will furnish space for 4,000 municipal and county workers. The building is located between Woodward, Larned, Randolph and Jefferson Avenues, in downtown Detroit.

Steel for Detroit's City-County Building Erected in 5½ Months

The people of Detroit are going to have their attractive new City-County Building a lot sooner than they expected, thanks to a fast job of steel erection.

A number of unusual engineering problems were involved in erecting the 8,200 tons of structural steel. For instance, the plans called for three-story tiers and columns which take considerable time to erect. Another difficulty was the complete absence of storage space at the mid-city site. Furthermore, the use of crawler cranes was complicated by congested basement areas, as well as underground piping, caisson foundations and elevator-pit openings.

Bethlehem engineers devised various measures to cope with these problems. The two units were erected separately, with closely-coordinated use of three big guy derricks. To compensate for the absence of storage space, Bethlehem set up storage yards a mile from the erection site. The steel was trucked directly to the derricks, right over shored sections of the basement area. Excessive congestion on the floor area around the derricks due to the three-story tiers was avoided by providing additional installments of columns and spandrel beams. These were then erected before any interior beams were brought to the floor.

Thanks to careful planning—and with an assist from favorable weather—the steelwork was completed in just 5½ months, far ahead of schedule.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

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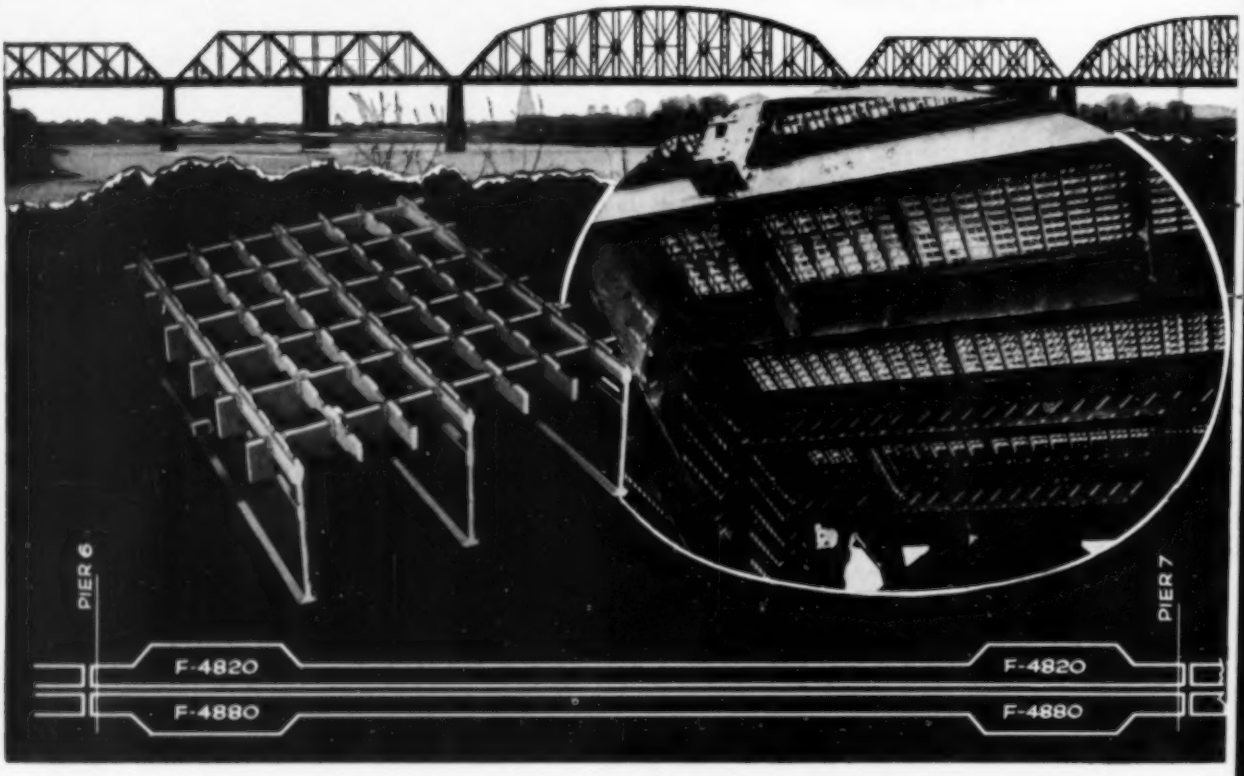
Another costly maintenance problem

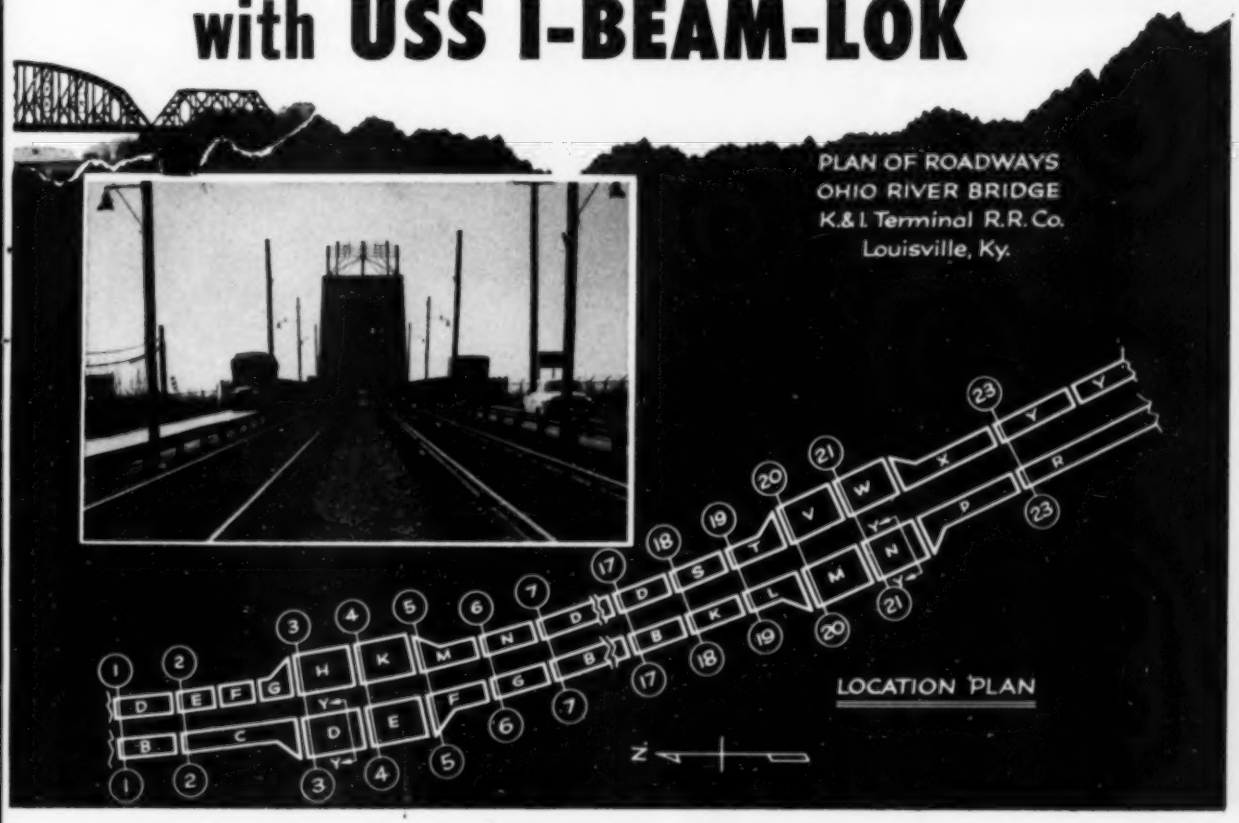


K & I Terminal R R Company replaces troublesome roadways

A SECTION of the west roadway of the south approach showing the smooth-riding, skid-resisting, self-cleaning surface of USS I-Beam-Lok Open Steel Flooring as it widens out to provide a passing area.

THIS IS A VIEW of the east roadway of the south approach showing curve and elevations. Note narrowness of roadway and the heavy concentration of wheel loads that made old block roadways so expensive to maintain.

solved by reflooring old bridge with USS I-BEAM-LOK



on Ohio River bridge with modern open steel flooring

• Another important old bridge has taken a new lease on life. And what a welcome relief to its owners, the Kentucky and Indiana Terminal Railroad Company, who had the costly problem of maintaining the obsolete laminated wood deck and asphalt surfaced roadways!

Neither the original 3½" x 9" wood block flooring on the present bridge which was completed in 1913, nor the still heavier floor which replaced it were adequate for the traffic of the times. So, in 1949, finally fed up with the endless problem of trying to maintain the troublesome old flooring, the owners experimented with an open type steel deck on 120 feet of roadway.

The results were so satisfactory, that in 1951 USS I-Beam-Lok was used on the east roadway of the south approach. In 1952, USS I-Beam-Lok was laid on the east roadway of the bridge proper. And in 1953, the entire west roadway was refloored with USS I-Beam-Lok.

In all, 1,708,000 pounds of 5" USS I-Beam-Lok Open Steel Flooring was used to cover the two 11' x 4098' roadways of the approaches and bridge. All work was done at night, and without interruption of traffic!

By using 5" open steel flooring, which weighs 18.8 pounds psf as against 60 pounds psf for the old flooring, it was possible to save approximately 3,739,820 pounds in the weight of the floor.

USS I-Beam-Lok Open Steel Flooring is available in units measuring 6'2" in width and up to 49' in length. In many cases it can be applied directly to stringers on spans up to 4' centers to permit H-20 loadings without secondary supports. It can be erected easily and speedily on reflooring projects such as this with a minimum interruption of traffic.

For more information about this modern lightweight open steel flooring (USS I-Beam-Lok is also available in concrete-filled type), contact the sales office nearest you.

UNITED STATES STEEL CORPORATION, PITTSBURGH • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
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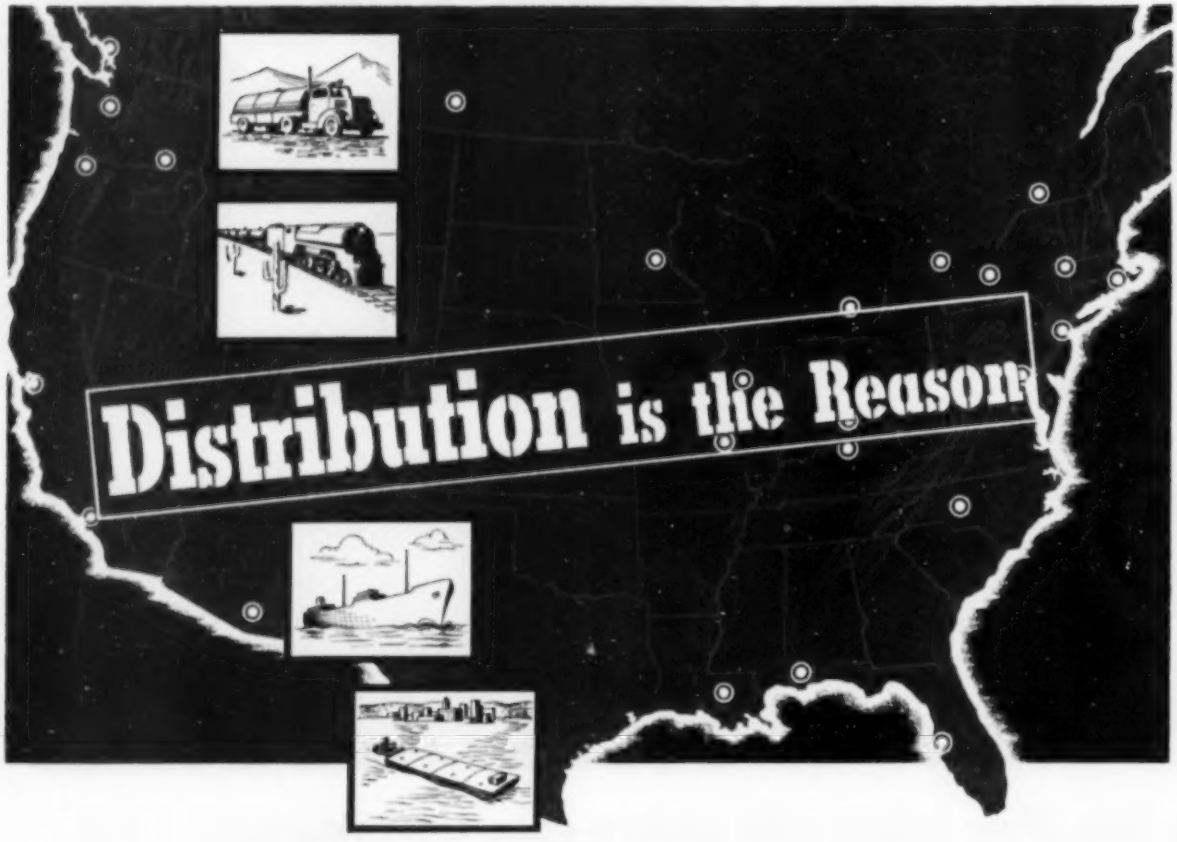

FROM COAST-TO-COAST throughout this country, an ever-increasing number of Roadbuilders are specifying Bitumuls for all types of surfacing. These men specify Bitumuls for two good reasons:

1. They know that they can get Bitumuls *when and where they need it,* in the quantity and grade required.
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Back of this ready availability of Bitumuls is a system of distribution that is without parallel in the industry. From our many refineries and plants, Bitumuls moves in steady stream — by truck, rail, boat, or by barge — to local storage-points across the nation. Here it is held in readiness for immediate job-delivery or for pick-up by the Roadbuilder.

National distribution is, of course, only one of the reasons why more surfacing is being done with Bitumuls. Cold-applied emulsified asphalt in this modern, convenient form offers important savings in time, labor and equipment. New illustrated booklets, available on request, give full technical information and methods of application. Write for your copies today.

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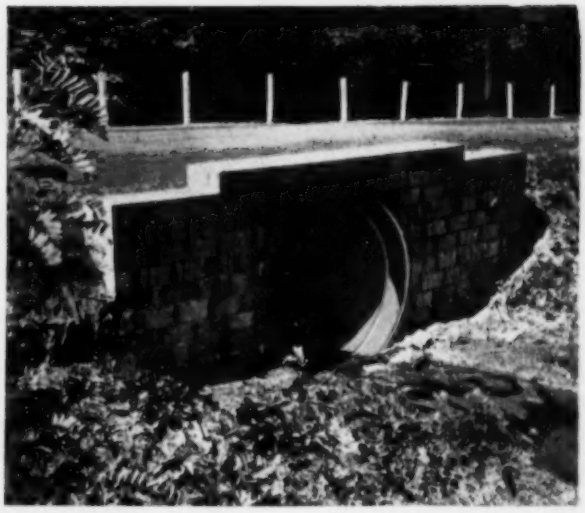


Replace Old Bridges Economically with CONCRETE PIPE

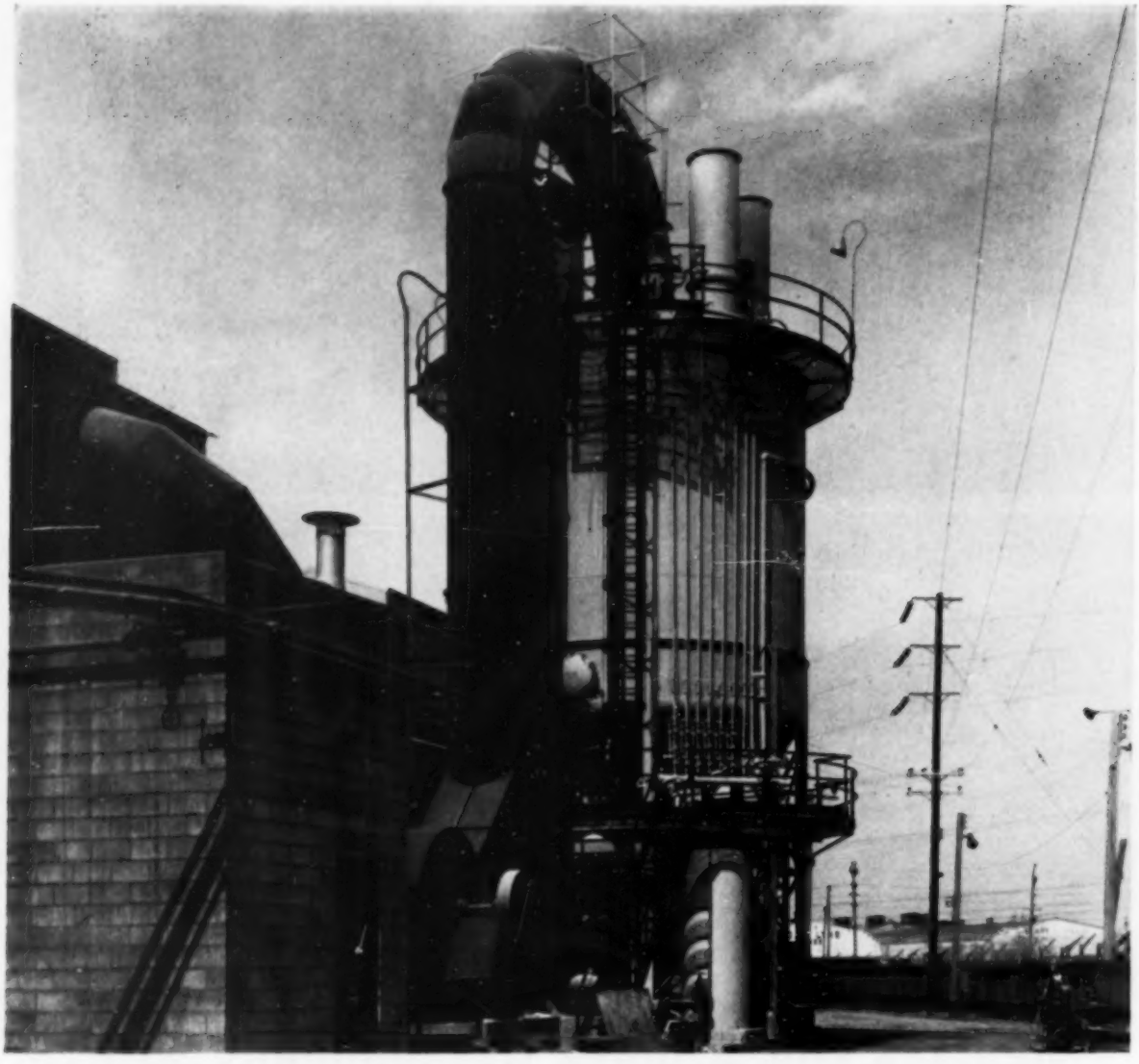
Many old bridges have become hazards because they provide inadequate road width or sight distance or have insufficient strength for today's traffic. These dangerous conditions can be corrected easily and economically by replacing the bridges with concrete pipe culverts.

The photos above show four such replacements in Hamilton County, Ohio. They are part of a vast program to modernize inadequate road drainage in the county. Since concrete pipe is easy to install, the program requires a minimum expenditure of time, manpower, equipment and money. At most locations the waterway area is reduced because of concrete pipe's great carrying capacity.

Concrete pipe culverts have adequate strength to resist heavy loads and impacts. They have maximum hydraulic capacity. They are moderate in first cost, require little or no maintenance and have unusual durability. That means they will deliver dependable, *low-annual-cost* service.

AMERICAN CONCRETE PIPE ASSOCIATION

228 NORTH LA SALLE STREET, CHICAGO 1, ILLINOIS



Precipitator Recovers Two Tons of Ore Dust a Day

Shown above is a 22-ft. 6-in. diam. by 22-ft. 7-in. precipitator shell built by Chicago Bridge & Iron Company for Western Precipitation Corporation. It was installed at the Barium Products, Modesto, Cal., plant, operated by the Westvaco Mineral Products Division of Food Machinery and Chemical Corporation.

The Barium plant manufactures a substantial number of barium chemicals, the most important of which are barium oxide and barium hydrate in one or more of their various forms.

The precipitator was installed to recover valuable barium ore dust that is produced during furnace operations. Tests prove that the precipitator collects over 95 per cent of the material fed to it or, roughly, two tons per day. Not only is this a great savings in material—it also helps prevent pollution of the atmosphere and surrounding vegetation.

This precipitator shell is another example of the wide range of welded steel plate structures that CB&I is equipped to build for industry. In addition to special structures of this type, we regularly build elevated water tanks and pressure storage vessels for every need.

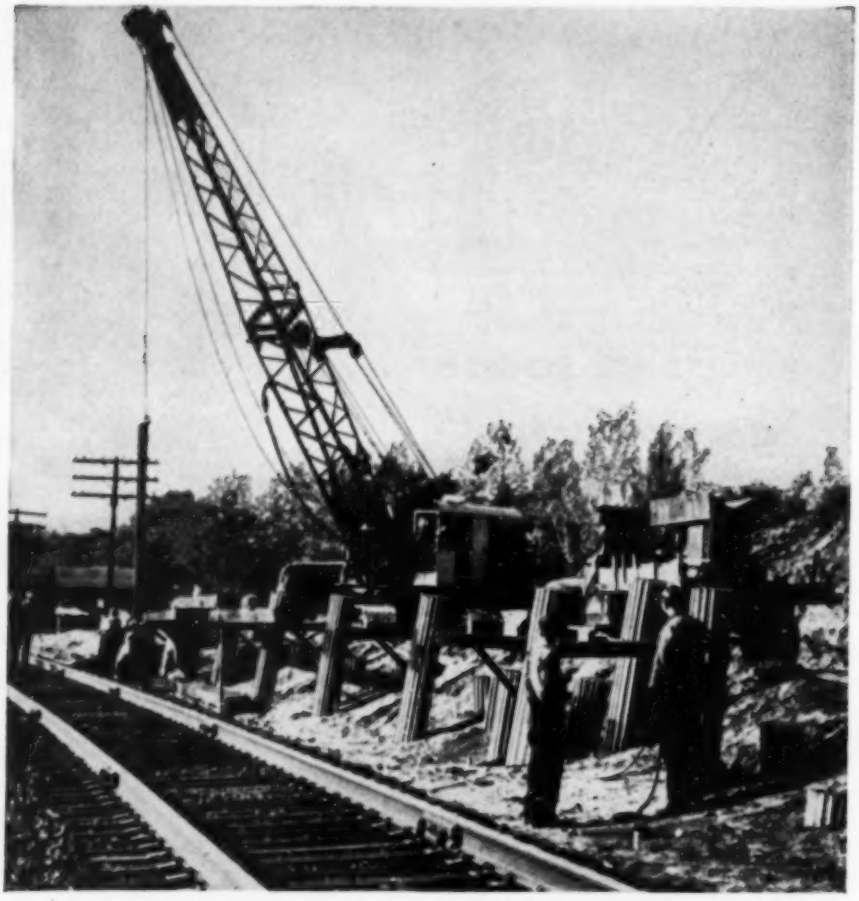
Write our nearest office for information, estimates or quotations the next time you plan welded steel plate structures of any sort. CB&I engineers will be happy to provide any help you may need.

CHICAGO BRIDGE & IRON COMPANY

Atlanta 3 ..... 2167 Healey Bldg.	Detroit 26 ..... 1541 Lafayette Bldg.	Pittsburgh 19 ..... 3210 Alcoa Bldg.
Birmingham 1 ..... 1596 N. Fiftieth St.	Houston 2 ..... 2128 C & I Life Bldg.	Salt Lake City 4 ... 509 West 17th South St.
Boston 10 ..... 1009—201 Devonshire St.	Los Angeles 17 ... 1556 Gen. Petroleum Bldg.	San Francisco 4 ..... 1584—200 Bush St.
Chicago 4 ..... 2199 McCormick Bldg.	New York 6 .... 3395—165 Broadway Bldg.	Seattle 1 ..... 1309 Henry Bldg.
Cleveland 15 ..... 2263 Midland Bldg.	Philadelphia 3 .. 1652—1700 Walnut St. Bldg.	Tulsa 3 ..... 1647 Hunt Bldg.

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNA.

Here Monotubes are being driven to support a railroad overpass.



Monotube Foundation Piles

Will fewer piles meet your load requirements?

. . . check these MONOTUBE features!

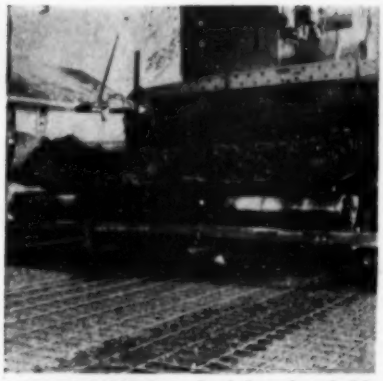
THIS question about *fewer* piles is something you might want to check into carefully, because it could save plenty of dollars. Here's a start . . .

Monotube piles have exceptional bearing capacity. There's plenty of data and proof on their excellence in transmitting loads to the penetrated soil. This, plus visual top-to-bottom assurance of their condition after driving, permits designing for heavy loads.

Consider, too, Monotubes' high-strength, cold-rolled construction, field extendibility, and large-area vertical fluting. Everything adds up to important design possibilities and new construction economies.

For additional, specific data, write to The Union Metal Manufacturing Co., Canton 5, Ohio.

UNION METAL



MANY APPLICATIONS of reinforced asphaltic concrete, some in service on test roads for many years, indicate that you should reinforce your next asphaltic concrete resurfacing job with American Welded Wire Fabric.

PRE-CAST CONCRETE slabs and planks should be reinforced with American Welded Wire Fabric. American Fabric is strong and light in weight, can be stressed about 40% higher than other types of reinforcement.

PREFABRICATED SHEETS of American Welded Wire Fabric provide a long lasting, smooth riding road surface. They are easy to handle.

New ASTM Specification A185-53T is only a starting point for American Welded Wire Fabric

CONCRETE HIGHWAYS can be built with longer slabs and fewer joints if they are reinforced with American Welded Wire Fabric.

WE don't work *up to* the new ASTM Specification A185-53T when we manufacture American Welded Wire Fabric. We consider these standards minimums, just as they were intended to be. And, while keeping our price competitive, we build as much extra strength and quality as we can. As a result, American Welded Wire Fabric surpasses ASTM specifications. It gives you extra assurance that your concrete structures will be every bit as strong as you design them.

AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL CORPORATION, GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
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EVERY TYPE OF REINFORCED CONCRETE CONSTRUCTION NEEDS

USS AMERICAN WELDED WIRE FABRIC

UNITED STATES STEEL

NEWS OF ENGINEERS

John R. Dietz, for the past twelve years in charge of the highway division of Gannett Fleming Corddry and Carpenter, Inc., Harrisburg, Pa., was recently elected a vice-president.

Edgar E. Foster announces the opening of an office in Denver, Colo., for work on flood control, hydroelectric power, drainage and related developments. Previously a hydraulic engineer for the Kuljian Corp., Philadelphia, Pa., Mr. Foster will retain an affiliation with the firm.

Charles O. Gunther, professor emeritus of mathematics and ordnance engineering at Stevens Institute of Technology, has been named research consultant for the L. B. Foster Co., which has offices in Pittsburgh, New York, Chicago, Houston and Los Angeles. A specialist in ballistics and mathematics, Professor Gunther is author of several books in the field.

R. A. Harris, chief engineer of the Mississippi State Highway Department at Jackson, Miss., has resigned after twenty years in the post to accept a position as provisional adviser in highway maintenance with the Colombian government at Bogota. He will be succeeded by **Eugene M. Johnson,** bridge engineer with the highway department since 1933.

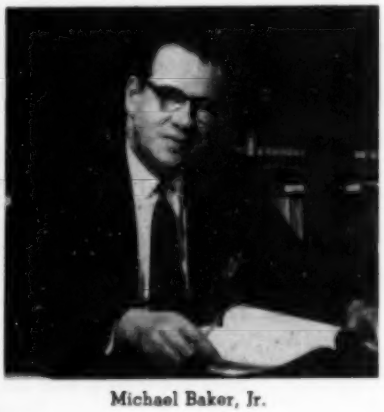
R. E. Crawford, formerly engineer for Fay, Spofford & Thorndike, Boston, Mass., is now vice-president of Green Engineering Affiliates, Inc., with offices at 84 State St., Boston.

Tom H. Rankin, of Manhasset, N.Y., vice-president of James Stewart & Co., Inc., of New York and James Stewart Corp., of Chicago, has been elected a director of James Stewart & Co., Inc.

Mario Palmieri is now in Italy as representative of **D. B. Steinman,** designer of the Messina Straits Bridge, on preliminary work for the project. He will supervise subsoil borings to locate foundation rock in 400 ft of water at some 500 to 600 ft below sea level. The largest suspension bridge in the world, the projected structure will have a record center span of 5,000 ft.

Robert P. Woods, street railway commissioner of Kansas City, Mo., was one of three engineer members of the Kansas City Chamber of Commerce recently honored at a Chamber luncheon at the Hotel Muehlebach, in observance of National Engineers' Week (February 21–28). Other members similarly honored were **Robert E. McDonnell,** senior member of Burns and McDonnell Engineering Co., and the late **Maj. Gen. E. M. Stayton** (page 107).

Michael Baker, Jr., was among the 1954 recipients of the Horatio Alger Awards, presented under the auspices of the American Schools and Colleges Association at a luncheon in New York on May 6. The awards are presented annually to men "who have risen from humble beginnings to make records of achievement and service." Mr. Baker is president of the consulting engineering firm, Michael Baker, Jr., of Rochester, Pa., which he established less than ten years ago.



Michael Baker, Jr.

Jesse E. Buchanan

Bernard E. Gray

Jesse E. Buchanan, has resigned as president of the University of Idaho to succeed **Bernard E. Gray** as president of the Asphalt Institute, New York. Professor Buchanan has been on the University of Idaho staff since his graduation there in 1927. He advanced to the position of dean of the college of engineering in 1938, and in 1946 following wartime service in the Army, became president. Mr. Gray has been with the Institute since 1930, advancing from highway engineer to general manager and president. Professor Buchanan will assume his new post on July 1.

John J. Reilly has been appointed chief appraisal engineer of Ebasco Services, Inc., responsible for the supervision and preparation of engineering valuations and depreciation studies. Except for a period of military service in World War II, Mr. Reilly has been with Ebasco Services continuously since 1937.

Adolph J. Ackerman, consulting engineer of Madison, Wis., is one of six alumni of the University of Wisconsin honored for "outstanding accomplishment" at the annual Wisconsin Engineers Day on May 7. Before establishing his consulting practice in Madison in 1952, Mr. Ackerman was in São Paulo, Brazil, for six years as vice-president in charge of hydroelectric construction for the Rio de Janeiro and São Paulo Tramway, Light and Power Companies.

Jean E. Hittle has been appointed assistant engineer of research for the Asphalt Institute—a position recently established as a part of the Institute's expanding engineering development program—with headquarters at 801 Second Avenue, New York City. For the past three years Mr. Hittle has been materials engineer for the New Mexico State Highway Department at Albuquerque.

Louis S. LeTellier retired as dean of The Citadel, the Military College of South Carolina, on April 30, after 46 years in the service of the college. He was cited by Gen. Mark W. Clark, president of The Citadel, for his services to the college, the state, and the civil engineering profession. Ceremonies marking his retirement included a dress parade by the Corps of Cadets and the unveiling of a marble plaque in his honor.

(*Continued on page 28*)

News of Engineers

(Continued from page 27)

Thomas E. Harding, for the past twenty years city engineer of Pawtucket, R.I., was recently appointed to the post of deputy state public works director.

Hans H. Bleich, professor of civil engineering at Columbia University, has been appointed technical director of the Institute of Air Flight Structures, established in January as a national educational and research center for the study of air flight structures, particularly in the supersonic range of jet and rocket-powered aircraft and guided missiles. Dr. Bleich is currently

Hans H. Bleich

doing research on structural theories for submarine hulls for the Office of Naval Research. **Alfred M. Freudenthal,** professor of civil engineering at Columbia, has been appointed to assist him.

Edmund H. Lang, lieutenant colonel, U.S. Army ROTC, and senior engineer instructor in the department of military science and tactics of Pennsylvania State University, has been awarded the Legion of Merit for meritorious service in Korea. The medal was given for his "Exceptionally meritorious conduct in the performance of outstanding service" as staff engineer in the War Planning Division of the Army's Far Eastern Headquarters' Engineer Section and as chief of the Section's Operations and Training Division from August 1950 to July 1953.

Irving E. Chapman was recently named vice-president and director of the Mitsubishi Oil Company, Ltd., a subsidiary of the Tide Water Associated Oil Co., with headquarters in Tokyo, Japan. For several years Mr. Chapman has been assistant manager of operations of the western sales division of the Tide Water Associated Oil Co.

Walter H. Tacke, former expressway engineer for Milwaukee, has been appointed deputy commissioner of Public Works for the city. During 19 years in municipal service, Mr. Tacke has spent the greater part of his time in the Bureau of Street Construction.

J. E. Hoving, assistant to the chief engineer of the Northern Pacific Railway, at St. Paul, Minn., has been appointed to the post of assistant chief engineer, with headquarters at Seattle, Wash.

Samuel B. Morris, general manager and chief engineer of the Los Angeles Department of Water and Power, received the distinguished service award of the American Public Power Association at its recent annual meeting in Chicago. Mr. Morris, who is a Director of ASCE and a past-president of APPA, was praised for his "long and outstanding service to his community, the nation, and the APPA."

Col. Louis H. Foote, formerly district engineer of Alaska, will succeed **Brig. Gen. Don G. Shingler,** who is retiring as the North Pacific Division Engineer for the Corps of Engineers, with headquarters at Portland, Oreg.

Paul W. Schoenlaub, former president and general manager of Dallas Homes, Inc., Dallas, Tex., is now manager of the Newark (N.J.) district residential sales organization of United States Steel Homes, Inc., the U. S. Steel housing subsidiary. The district includes the New York and New England territory.

S. S. Steinberg, dean of the college of engineering at the University of Maryland, just returned from a month-long trip to South America and the Caribbean area where he made a study of technical education and engineering in British and Dutch Guiana for the Foreign Operations Administration. He also visited technical training facilities in Trinidad, Puerto Rico and Jamaica.

B. K. Hough, of Ithaca, N.Y., announces the opening of an office for private consulting practice in the field of soils engineering, under the firm name of B. K. Hough, Consulting Engineer, in the Seneca Building, Ithaca. The firm will take over the practice previously conducted under the name, Hough Soils Engineering Laboratories.

Levant R. Brown, assistant division engineer for Division 7 of the U. S. Bureau of Public Roads, with headquarters in San Francisco, Calif., recently received the Department of Commerce Meritorious Service Award in recognition of 40 years of "extremely competent leadership and service as a highway engineer with the Bureau. . . ."

Jack D. Stevens has been engaged as consultant to the Puget Sound Utilities Council with offices in Seattle, Wash. In his new assignment, Mr. Stevens will analyze future power needs and recommend steps to be taken in meeting these needs in relation to load growth and economic aspects of the region. He was formerly with the Bonneville Power Administration as chief of power resources in charge of current and long-range power investigations and the hydraulic operations of the Federal Columbia River Power System.

W. H. Oswalt has resigned as city manager of Midland, Tex., to accept an appointment as vice-president of the Southland Life Insurance Co., Dallas, Tex., where he will act as coordinator on construction of the Southland Center. **J. M. Orman,** who has been director of public works for Midland for the past three and one-half years, succeeds Mr. Oswalt as city manager.

(Continued on page 31)

Traffic delayed only 31 hours on this unusual bridge replacement job!


1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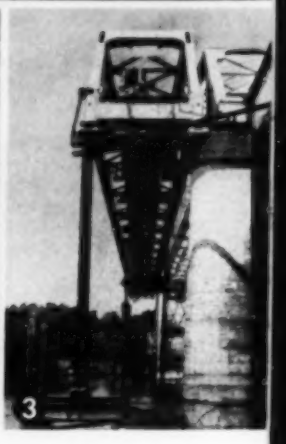
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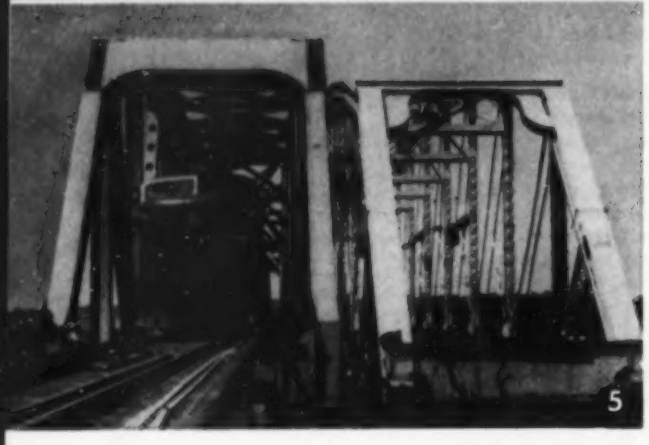
4


5

AMERICAN BRIDGE
floats new bridge onto old piers to give GM&O RR fast service!

THE replacement of the Gulf, Mobile and Ohio Railroad Company's bridge over the Warrior River at Tuscaloosa, Alabama, with a new structure on the existing piers is another good example of how American Bridge handles a difficult job.

The project involved the design, fabrication and erection of the 450-foot bridge (consisting of a 275′ anchor span, a 58′4″ cantilever arm, and a 116′8″ suspension span) on the original piers, and the removal of the old, out-moded bridge.

The entire new bridge (picture #1) was erected on two barges (picture #2) and floated into a temporary position on pier extensions alongside the old structure (picture #3). The old bridge was then moved off its piers (picture #4) and the new bridge rolled onto the existing piers with new rails, crossties and new timbers in place (picture #5).

The changeover was accomplished with a traffic interruption of only thirty-one hours!

Handling unusual jobs like this with such ease and speed has made American Bridge the country's number one builder of railroad bridges. Whether your requirements are for a new line structure, or for an emergency repair or replacement job, American Bridge welcomes your inquiries.

AMERICAN BRIDGE DIVISION, UNITED STATES STEEL CORPORATION · GENERAL OFFICES: 525 WILLIAM PENN PLACE, PITTSBURGH, PA.

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UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

AMERICAN BRIDGE

UNITED STATES STEEL

News of Engineers

(*Continued from page 29*)

Rodney F. Coltart has been promoted from sales engineer at the Colmar (Pa.) plant of the Link-Belt Co., to sales manager of the firm's Central Pacific Division, with headquarters in San Francisco. He has been with Link-Belt since 1935.

J. C. Stevens, Past-President of ASCE, has retired from active participation in the consulting engineering firm of Stevens & Thompson, of Portland, Oreg., which he founded more than 33 years ago. Mr. Stevens will continue his activities with Leupold & Stevens Instruments, Inc., and the Gas Ice Corp. He will also serve as a consultant to Stevens & Thompson.

Clay Colley, Los Angeles consultant, has reopened his office at 4032 McClung Drive following release from active duty with the Navy. For the past two and a half years he has been on duty in Korea, Japan and Hawaii. Mr. Colley is currently representing the Alvey Ferguson Co., of Cincinnati, Ohio, and the Thermoid Co., Trenton, N.J.

Reuben E. Cole, since 1949 director of engineering and construction for the Atomic Energy Commission's Santa Fe Operations, resigned from his post effective June 5 to return to private construction practice. In his capacity as director, Mr. Cole supervised construction of major installations, and directed the planning and building of the nuclear test facilities at the Pacific and Nevada proving grounds.

Vernon A. Smoots, resident partner in charge of the New York office of Dames & Moore, has transferred to the firm's Los Angeles office to fill the vacancy left by the recent resignation of **L. LeRoy Crandall. Gardner M. Reynolds** has been advanced from assistant to the resident partner to resident partner in charge of the New York office.

J. Burch McMorran, chief engineer of the New York State Department of Public Works, Albany, N.Y., has resigned after 37 years of service to become chief engineer of the Power Authority of New York State with headquarters at 270 Broadway, New York. Mr. McMorran has been chief engineer since 1940 and has also served without compensation as chief engineer of the New York State Thruway Authority since 1950.

J. B. McMorran

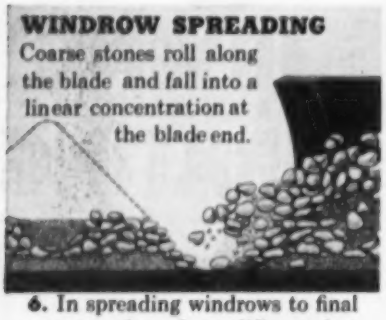
Reece H. Wengenroth, who recently joined King & Gavaris, New York consulting engineers, as chief engineer of bridges, is currently supervising the design of twenty structures on the Poughkeepsie arterial highway program for the New York State Department of Public Works. He was previously project engineer for Hardesty & Hanover and Knappen-Tippetts-Abbett-McCarthy.

HOW GRAVEL SEGREGATION IS CAUSED . . .

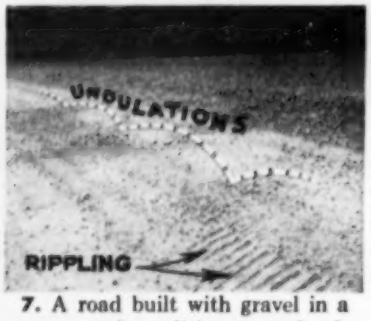
1. When aggregates are transported the bumping and vibration causes the fines (dust, small particles and chips) to sift to the bottom of the load while the larger stone works toward the top and sides.

2. When the load is dumped on the roadway, the material forms in piles. The larger stones roll from the truck first, the fines fall last. The segregated condition is now reversed; the coarse aggregates are in the base of the pile.

3. When the piles are leveled to specified depth, alternate pockets of fines and coarse are formed. Such segregation is highly unstable and a base course so constructed would soon ravel and break up.

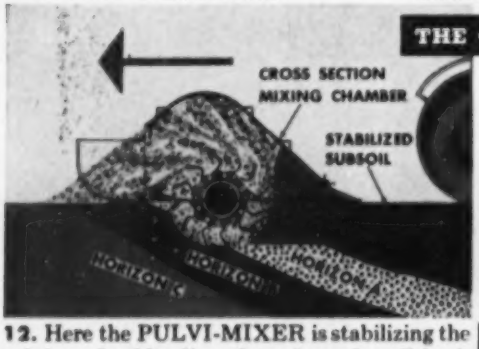


6. In spreading windrows to final crown and grade, a different but very unstable segregation is caused. Fines are found in concentration in the "heart" of the windrow. Some of these remain in a pocket; others sift to the bottom. Stones which are "topped" by the blade, are rolled to the surface.

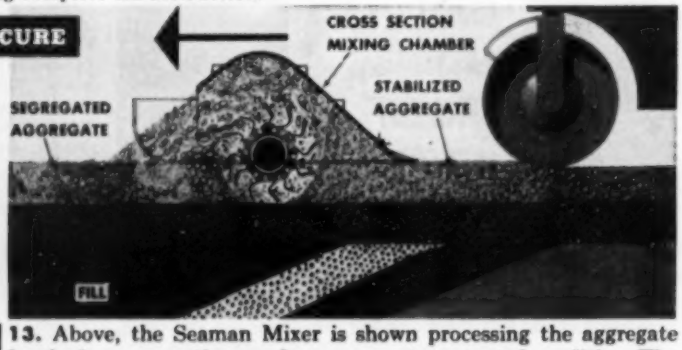


7. A road built with gravel in a segregated condition soon develops rippling, undulations, and a "wash-boardy" condition. Traffic keeps those non-keyed stones in motion. Rain trapped in the hollows seeps through and weakens base and sub-base. Freezing and thawing complete the destruction.

8. SUB-BASE failure is frequently caused by soils of different physical characteristics reacting unevenly to moisture. Here a weak spot is developing just below the base course. This would not occur if sub-base had been processed to blend the soils and eliminate voids.

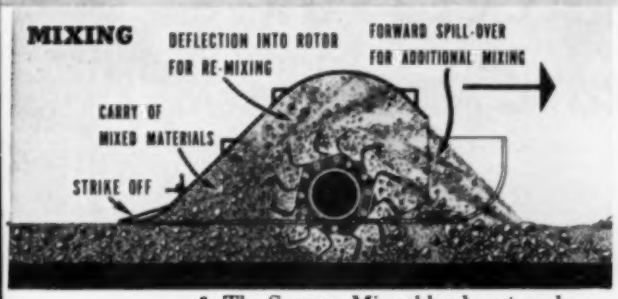


12. Here the PULVI-MIXER is stabilizing the sub-base by blending the sub-grade soil horizons (A, B, C,) to attain a course which is uniform in moisture, density and thickness. Weak spots such as that shown in the previous four diagrams will not occur and therefore the base will not require maintenance.



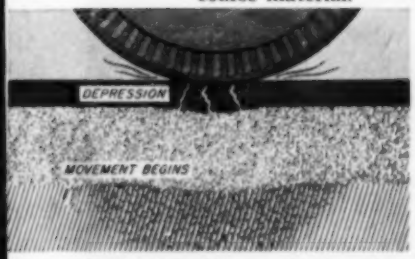
13. Above, the Seaman Mixer is shown processing the aggregate for the base, correcting an always-present segregated condition. The material has previously been shaped to final crown and grade. No further blading is needed, for the PULVI-MIXER not only completes the mix but also leaves it in a partially compacted condition, exactly to the grade established, ready for final rolling. This partial pre-compaction is needed because materials left too fluffy are subject to segregation during compaction.

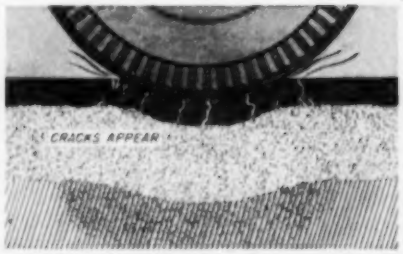
. . . HOW THE SEAMAN MIXER CORRECTS IT

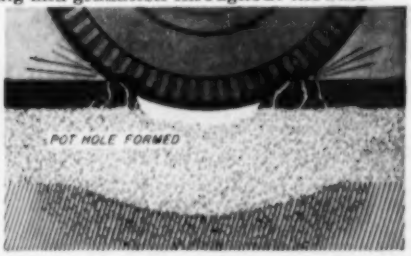


4. The Seaman Mixer blends out pockets of coarse and fines so that particles of each size, from dust up to the largest stone, are intermixed throughout the base. Voids are filled with fines to mortar-in the keyed and interlocked coarse material.

5. It is essential in eliminating pockets of coarse and fines to cross-mix as well as to mix in a longitudinal direction. Only the Seaman Mixer is capable of this operation which provides complete and uniform material placement, blending and gradation throughout the base.







9. The breakdown of the sub-base through the disintegrating effect of moisture is reflected in a localized movement of the materials in the base.

10. As traffic continues to pound the base, cracks develop and the sub-base is weakened further. Sub-base and base course deflections are unequal and the beam effect of the base is unable to carry the load.

11. Complete breakdown of the base course above the sub-base failure has started a chain reaction as more moisture will permeate the fault and establish repeated breakdown cycles along the width and length of the pavement.

For a complete description of the SEAMAN TRAV-L-PLANT and the SEAMAN Self-Propelled Mixer, write for Bulletin TPS. Send a postcard today.

SEAMAN MOTORS Inc.

291 No. 25th St.
Milwaukee 3, Wis.

SEAMAN TRAV-L-PLANT. Equipped with pump, tachometer, volumetric meter and spray bar for closely controlled application of bituminous binders or water.

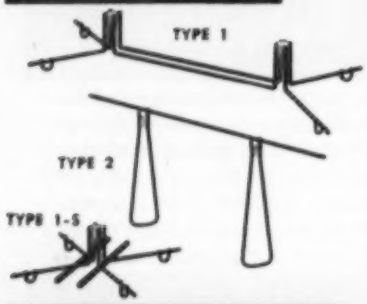
Only SUPERIOR Offers

Complete PLUS

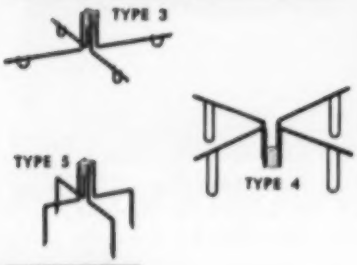
TILT-UP ACCESSORIES

Complete Engineering!

PICK-UP INSERTS



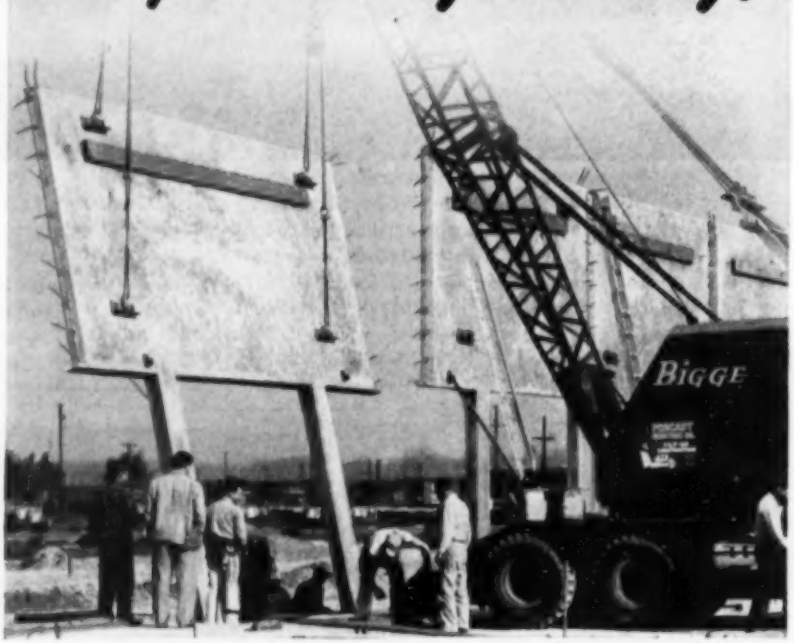
ANCHORS for BRACES



BRACES

COMPLETE ENGINEERING SERVICE

Our recommendations will be given without charge or obligation on receipt of a set of plans.



***42,000 LB. PANEL** being raised into position at United Grocers Warehouse, Fresno, Calif. Concrete panels are 8-inches thick with 12-ft. legs. SUPERIOR Pick-Up Inserts, Brace Anchors, and Braces were used. The exclusive pivoting action of the adjustable Braces permitted quick positioning and alignment of the panels. Contractor: Precast Erection Company, Niles, California.*

Tilt—Lift—Position!—The proper type of Pick-Up Inserts and Brace Anchors and their location in the slab or precast structural member is of prime importance in order to withstand the stresses occurring when *tilting, lifting,* and *positioning.*

As pioneers in this field, SUPERIOR has developed various types of accessories and correct procedures and techniques resulting from the experience of thousands of job applications.

The many types of SUPERIOR Inserts, Anchors, and Braces for every job condition together with complete engineering service provide a combination which offers safe and efficient handling of any precast panel or structural member.

For details request a copy of Bulletin TU-2.

SUPERIOR CONCRETE ACCESSORIES, INC.

4110 Wrightwood Avenue, Chicago 39, Illinois

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Pacific Coast Plant
2100 Williams St., San Leandro, Calif.

do you know that

The South Carolina Highway Department has accepted more competitive bids for engineering services? A recent protest of the ASCE Executive Committee against the practice as "unprofessional and opposed to the public interest" has been rejected by the Highway Department (details on page 73).

EJC is making new efforts to unify the profession? The first of two articles by Thomas A. Marshall, Jr., former secretary of EJC, discusses areas in which an effective unity organization might operate to achieve professional goals (page 42).

The world's third tallest structure is not in New York or any other city? A 1,212-ft radio transmission tower has been built in the wastes of Greenland. Maj. Gen. S. D. Sturgis, Jr., Army Chief of Engineers, writes on design and construction of the project, which is at Thule Air Force Base, in this issue (page 59).

The AIEE has a new secretary? H. H. Henline has retired after 22 years as secretary of the American Institute of Electrical Engineers, and is succeeded by Nelson S. Hibshman, former assistant secretary (page 88).

April construction activity is at a new peak for the month? With dollar outlays for new work rising 9 percent from March to $2.8 billion, more than $10 billion has been spent for construction in the first four months of this year—slightly above the record-breaking 1953 figure for the period. The Department of Commerce analysis is on page 90.

EJC is urging more use of engineers and private industry in nuclear developments? Reaffirming a stand it took a year ago, EJC is seeking congressional revision of present laws to permit broadened participation in the development of atomic energy (page 75).

ASCE Student Chapter are ending a notable year? Some of the large student-sponsored conferences and other activities are reported in "Society News."

Brooklyn Bridge has had a face-lifting job? After a four-year, $7,000,000 overhaul, the 71 year-old bridge is back in full service. It has six lanes now instead of four, and a daily capacity of 50,000 cars in comparison with its 1949 capacity of 37,244 cars (page 90).

Winds more than three times the speed of sound will be created in a new supersonic wind tunnel? A huge eleven-stage compressor that will create winds of 2,000 mph is being readied for installation in the Ames wind tunnel at Moffett Field, Calif. Construction and shipping of the 2,600,000-lb unit are described on page 91.

The St. Lawrence Seaway has been authorized? Details of this and other legislation important to engineers are summarized in the "From the Nation's Capital" page, which appears on page 86.

Plans for a new Engineering Societies Center are in the offing? A Committee of Five Presidents has been set up to speed the selection of a site for the proposed center and to work with United Engineering Trustees in settling the many other details involved. Latest developments in the situation are reported on page 75.

The ground is gradually sinking in the industrial area of Houston, Tex.? The cause, which has been found to be declining artesian water pressure, is discussed by Mason Lockwood, a Houston engineer and Vice-President of ASCE, in an article on page 48.

There is a practical new method of removing salt from water? Reclamation of saline waters by electrodialysis promises to be economically feasible, Rolf Eliassen says in an article on page 44.

Several important anniversaries are being celebrated this year? Both the American Society of Mechanical Engineers and the U. S. Geological Survey are 75 years old, and the Waterways Experiment Station of the Corps of Engineers 25 years old.

Evaporation from Lake Mead during the period of a year totals 900,000 acre-ft? This evaporation, the equivalent of depleting the reservoir to a depth of 7 ft, represents more water lost than most reservoirs hold when full. New studies made by the U. S. Geological Survey, in cooperation with the Bureau of Reclamation and the Weather Bureau, verify previous findings ranging from 5 to 9 ft, with the estimate centering on 7.5 ft.

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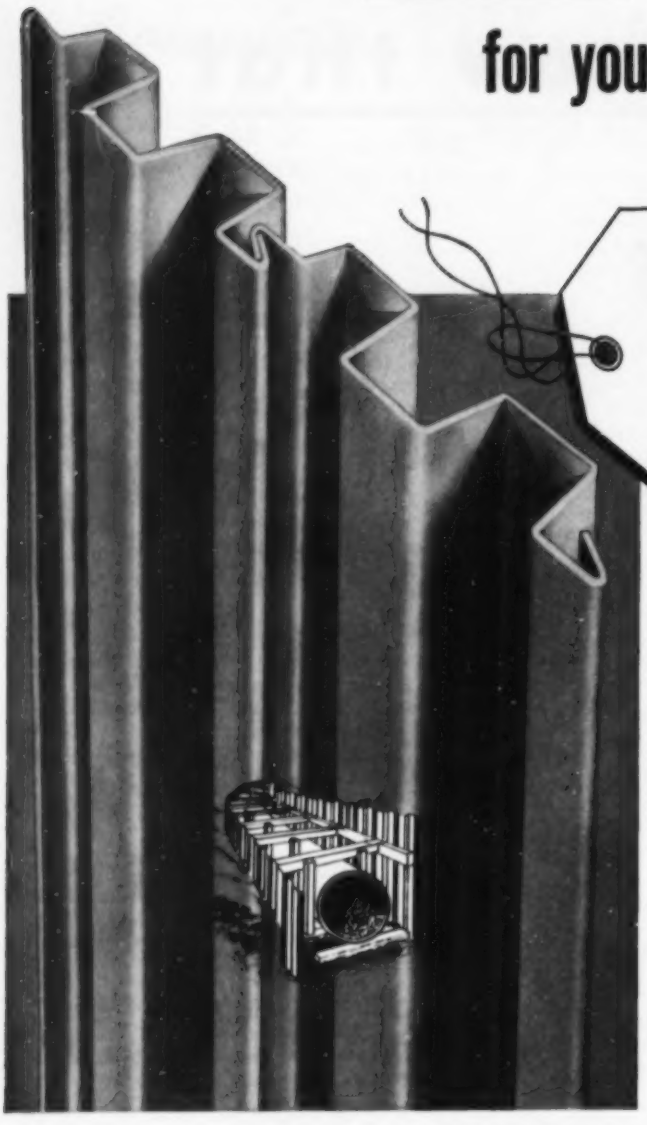

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CIVIL ENGINEERING
JUNE 1954
THE MAGAZINE OF ENGINEERED CONSTRUCTION

Lake Connell Dam is seen from downstream after filling of reservoir and from upstream before closure. It impounds 11,510 acre-ft above invert of discharge pipe. Spillway has no gates but flashboards 2 ft high can be added. Structure 82 ft high has central section 275 ft long and wing wall on right abutment 320 ft long, measured along top.

Connell Dam provides water supply for Alaska's first pulp mill

WILLIAM D. SHANNON, M. ASCE
and
WILLIAM L. SHANNON, A.M. ASCE
Partners, William D. Shannon & Associates
Seattle, Wash.

In the location, design and construction of the water supply for Alaska's first pulp mill, three main problems were encountered. These were difficult terrain, excessive precipitation, and the lack of adequate information on hydrologic, topographic, and geologic conditions. The Ketchikan Pulp Company's mill is now nearing completion on Ward Cove, approximately 10 miles northwest of Ketchikan, on Revillagigedo Island in southeastern Alaska (Fig. 1). Processing water for this mill will be obtained from Lake Connell located about three miles inland, within the Ward Creek drainage basin. A concrete gravity dam, 82 ft high at maximum section, and located 1,500 ft downstream from the outlet of Lake Connell, will store water for use dur-

FIG. 1. Pulp mill of Ketchikan Pulp Co. is supplied with water impounded by Lake Connell Dam and transported about 3 miles to mill site, mainly by wood-stave pipeline. If more water is needed, Lakes Talbot and Perseverance may later be dammed.

Rock slide in left abutment, looking downstream, created rock overhang. To excavate abutment and remove overhang would have held up construction schedule; therefore rock was underpinned by steel shores seen here, and lost rock replaced with concrete.

ing periods of low flow. Water will be transported from Lake Connell to the pulp mill, a distance of about 3 miles, through a wood-stave pipeline and two concrete lined tunnels, as shown on the map, Fig. 1.

Results of reconnaissance survey

In August 1948, preliminary investigations were begun to determine whether a suitable and adequate water supply, yielding an ultimate continuous diversion of 50 mgd, could be found on the island, and also to determine whether that source or another could be economically developed to produce sufficient hydroelectric power to supply mill requirements.

Revillagigedo Island covers some 1,134 sq miles, most of which is mountainous, the valleys and slopes being covered with timber. Over much of the island the mountains rise precipitously from tidewater to elevations of 2,000 to 4,000 ft.

Many small streams and a few larger ones drain the interior of the island. In many cases these streams, because of glacial action, have deep lakes along their courses with outlets cut through rock ridges. Often these streams drop hundreds of feet through steep-walled rock canyons in relatively short distances, resulting in conditions suitable for the economical development of hydroelectric power.

A reconnaissance survey of all the major streams on the island showed that the required hydroelectric power could be developed, but only at locations too distant from the proposed mill site on Ward Cove to warrant their economic development. This decision having been reached, it was then necessary to ascertain if Ward Creek, the closest sizeable stream to the proposed mill site, would provide a suitable and adequate supply of processing water for the mill.

Stream-flow measurements had been or were being made by the U.S. Geological Survey on a number of streams on the island, and there was a 6-year record of the flow of Perseverance Creek, tributary to Lake Connell. Ketchikan Creek, draining the area immediately to the south of Ward Creek, has been gaged continuously since 1909.

A gaging station was established on Ward Creek just below the outlet of Lake Connell in 1948. In addition, two precipitation stations were established, one near the mill site at tidewater and the second at Lake Connell. Records from all three of these stations were coordinated with the data obtained from other streams and weather stations on the island. It is interesting to note that the precipitation at Ketchikan ranges between 124 and 203 in. annually, with an average of 153 in. Precipitation at Lake Connell, based on limited records, is approximately 80 percent of that at Ketchikan. The drainage area of Ward Creek above the Connell Dam is 12.5 sq miles. Records to date indicate that the daily inflow to Lake Connell will range from a low of approximately 9 cfs, to more than 1,500 cfs, and with a monthly average inflow ranging from approximately 9 cfs to more than 350 cfs, averaging roughly 150 cfs.

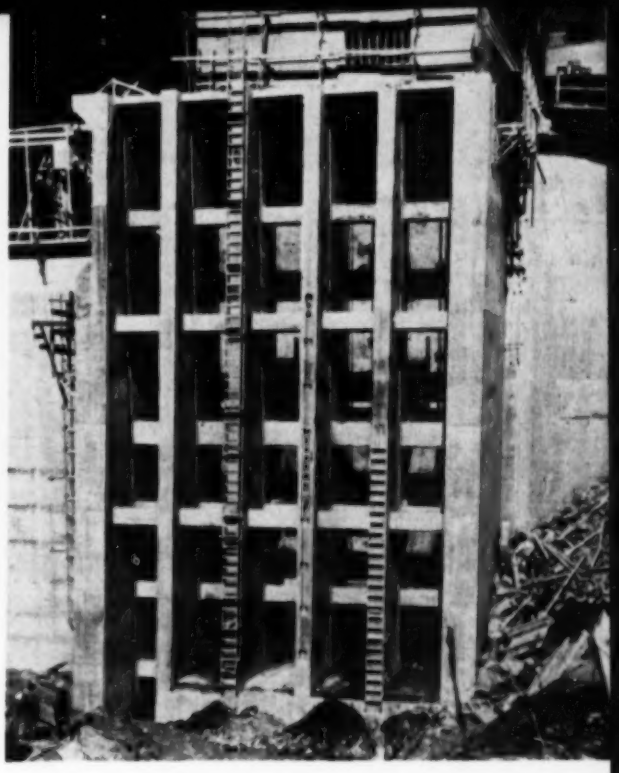
Hydrologic studies indicated that, for the pulp-mill requirements, a storage capacity of approximately 12,000 acre-ft is required for reasonable assurance of an uninterrupted water supply. Storage is needed primarily for the winter months, when freezing weather reduces runoff to a fraction of the average flow. Such periods of prolonged cold have lasted for as long as two months. Summer and late fall may also produce periods of reduced runoff. However, based on the runoff of Ketchikan Creek, these periods of low stream flow are not as severe as those occurring during the winter.

Lake Connell, raised to El. 250.0 by the Connell Dam, has a storage capacity of 11,510 acre-ft above the invert of the discharge pipe. If after several years of mill operation, it is found that this reservoir does not provide sufficient storage, additional storage can be developed at either or both of two locations—Lake

Spillway apron was provided with energy dissipators, seen at right, designed from model tests at University of Washington Hydraulic Laboratory. Spillway is designed for discharge of 15,000 cfs, at least twice estimated maximum flood.

Talbot and Lake Perseverance, both upstream from Lake Connell (Fig. 1).

Preliminary foundation explorations at the site of the Connell Dam were made in 1948-1949. Final foundation explorations were started in August 1951 simultaneously with the drawing of plans. Construction of the dam and pipeline commenced the following spring. The pipeline and tunnels were completed in January 1954, but the gates in the dam were closed in October 1953, allowing the reservoir to fill.



Intake to 3-mile pipeline leading to pulp mill is interesting feature of dam. Upstream face, seen here, has provision for conventional trash rack and trash rake for removal of floating debris. Intake has two identical sections, each with three gated openings to permit selection of best withdrawal level. Two 30-in. cast iron conduits extend through dam, one from each intake section.

Suitable rock at dam site

Foundation explorations indicated that suitable rock existed at generally shallow depths over the entire site. The deepest excavation to suitable rock, occurring at the downstream toe of the spillway apron, was approximately 20 ft. Generally only about 5 ft of partially weathered or unsuitable rock had to be stripped in preparation for the dam foundation.

Over the entire site the rock consists of phyllite, a metamorphic rock intermediate between slate and schist, containing frequent lenses and seams of white quartz. Its hardness varies substantially over the site. Over both abutment areas, including the narrow ridge on which the wing wall is founded, the rock was generally hard and blocky. In the stream channel softer rock was encountered. Downstream from the overflow section, some of the surface rock was sufficiently soft to be excavated in places without the systematic use of powder.

During the process of preparing the foundation for the overflow section and spillway apron of the dam, a rock slide occurred on the steep slope of the left abutment, looking downstream. This slide left a substantial overhang of rock just downstream from the dam. To excavate the abutment and remove this overhang would have entailed a substantial setback in the construction schedule; accordingly it was decided to underpin the abutment and replace the volume of rock lost by the slide with concrete. A photograph shows the slide area with steel underpinning wedged in place just before filling with concrete. The steel shores were prestressed by jacking and wedging. Steel anchor rods on approximately 5-ft centers were grouted into drilled holes 15 ft in depth over the slide area.

On account of the rock conditions, it was determined that a cutoff curtain of portland cement grout would be required to insure a satisfactorily tight dam. Two-inch holes were drilled on 10-ft centers on each of two lines spaced $2^1/_2$ ft apart, located 1 and $3^1/_2$ ft from the upstream face of the dam. These holes were first drilled to a 10-ft depth, grouted under 20 to 50 psi, then drilled to a 30- or 40-ft depth and grouted to refusal under 80 to 100 psi. On the left abutment, where the planes of schistosity are parallel to the ground surface, these pressures were substantially reduced to prevent displacement of the rock.

At locations where satisfactory grouting pressures could not be obtained with reasonable quantities of grout, additional holes were drilled and stage grouted using the split spacing procedure until the rock was satisfactorily sealed. Following the grouting, a line of 2-in. drain holes on 10-ft centers, located $8^1/_2$ ft from the upstream face of the dam, were drilled to depths of 15 to 30 ft. Drainage from these holes is collected in a pipe which leads to a manhole, and then is discharged onto the spillway apron.

The length of the central part of the dam, measured along the top, is 275 ft, while the length of the wing wall on the right abutment is 320 ft. Through the overflow section, the width from the upstream face to the downstream edge of the apron is 66 ft.

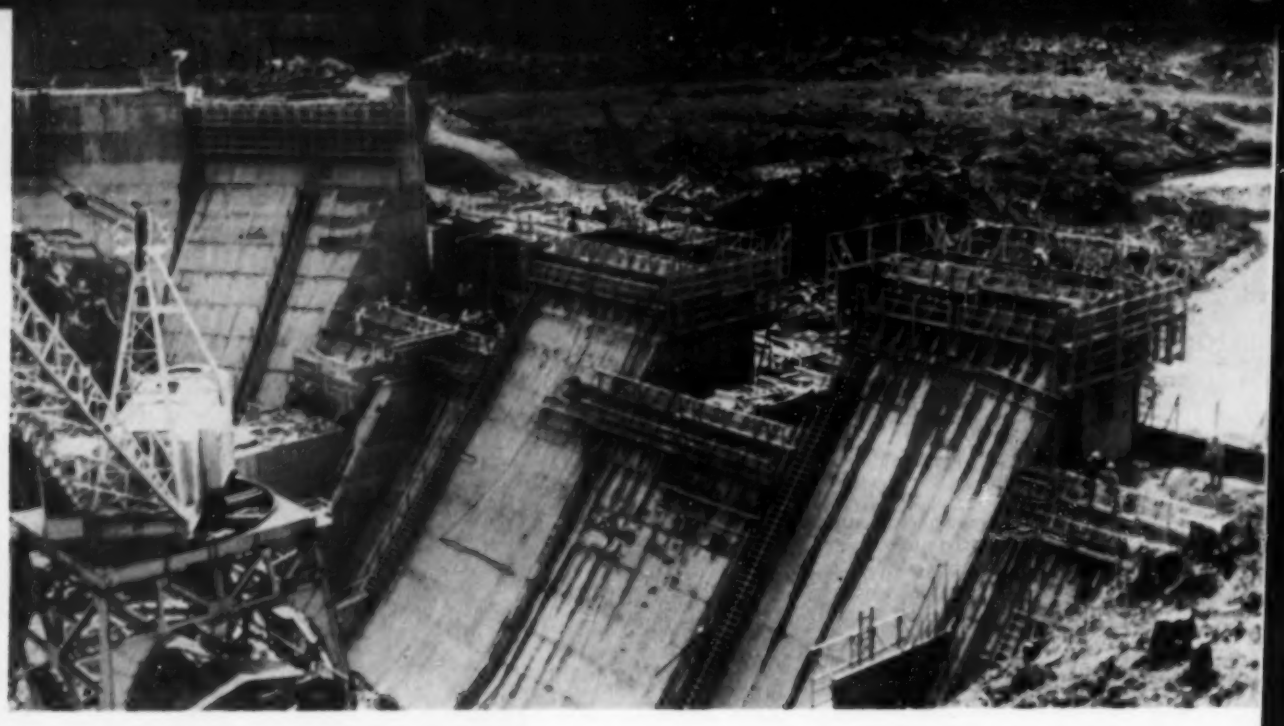
The spillway was designed for a discharge of 15,000 cfs, which is at least twice the estimated maximum flood. It is expected that this capacity will be ample even if the drainage area is logged of all standing timber. The overflow section, 113.5 ft in length, is divided into seven openings. No gates are provided although provision was made for flashboards 2 ft high.

Spillway apron for energy dissipation

In view of the condition of the foundation rock encountered in drill holes, it was decided at an early phase in the design to include a spillway apron to provide for energy dissipation. The slope of the apron was fixed as close as possible to the slope of the rock downstream from the dam, yet consistent with apron design. The energy dissipator was designed from tests on hydraulic models constructed and operated at the University of Washington Hydraulic Laboratory under the supervision of Prof. T.H. Campbell, A.M. ASCE.

The dam site was unwatered for construction purposes by the diversion of Ward Creek through a 16-ft diversion tunnel. Cofferdams protected the dam site area from flooding. Closure of the diversion tunnel was accomplished by a gated opening at the upstream portal, a permanent concrete plug being placed at the middle of the tunnel and grouted.

The 27,700 cu yd of concrete required in the dam were batched and mixed at the pulp-mill site, then transported to the dam in agitator trucks. Concrete was discharged



Fifty-ton whirley crane with 100-f boom, seen in both these views of downstream face, placed bulk of concrete in central part of dam. Remainder was placed by crawler crane, operated from crest of dam or close to

from trucks either directly into the forms or into a hopper used to fill either a 2- or a 4-cu yd bucket. A 50-ton whirley crane, to be permanently installed for material handling at the mill site, was temporarily erected on fill above the already placed concrete apron. This whirley with its boom of 100-ft radius was able to place the bulk of the concrete in the central part of the dam. The remaining concrete was placed by crawler crane operated either on the crest of the dam or immediately in front of the upstream face.

Aggregates were obtained by dredging from bars in the Unuk River, on the Alaska mainland, then hauled by barge 60 miles to the mill site. The uncertain river and tidal currents, coupled with the remoteness of the gravel deposit, made this phase of the work most trying for the contractor. However, this source was the most suitable that could be found within a reasonable distance of the site, based on the usual acceptance tests, including petrographic analysis for alkali-aggregate reactive substances. A deficiency of aggregate larger than $1^1/_2$ in., however, made it necessary to bring sufficient of the $1^1/_2$ to 3-in. size from Puget Sound, a distance of 700 miles.

Two mass concrete mixes were used for the bulk of the concrete. For the interior concrete, the mix contained aggregate of 3-in. maximum size with 4 bags per cu yd of Type II portland cement. The slump ranged from $1^1/_2$ to 3 in., with a water-cement ratio of approximately 0.53. On all exposed faces of the mass concrete, for a distance in from the face of at least 5 ft, the cement content was increased to 5 bags per cu yd with a water-cement ratio of approximately 0.42. Pozzolith, manufactured from a by-product of the pulp industry, was added to all concrete to act both as an air-entraining agent and as a plasticizer.

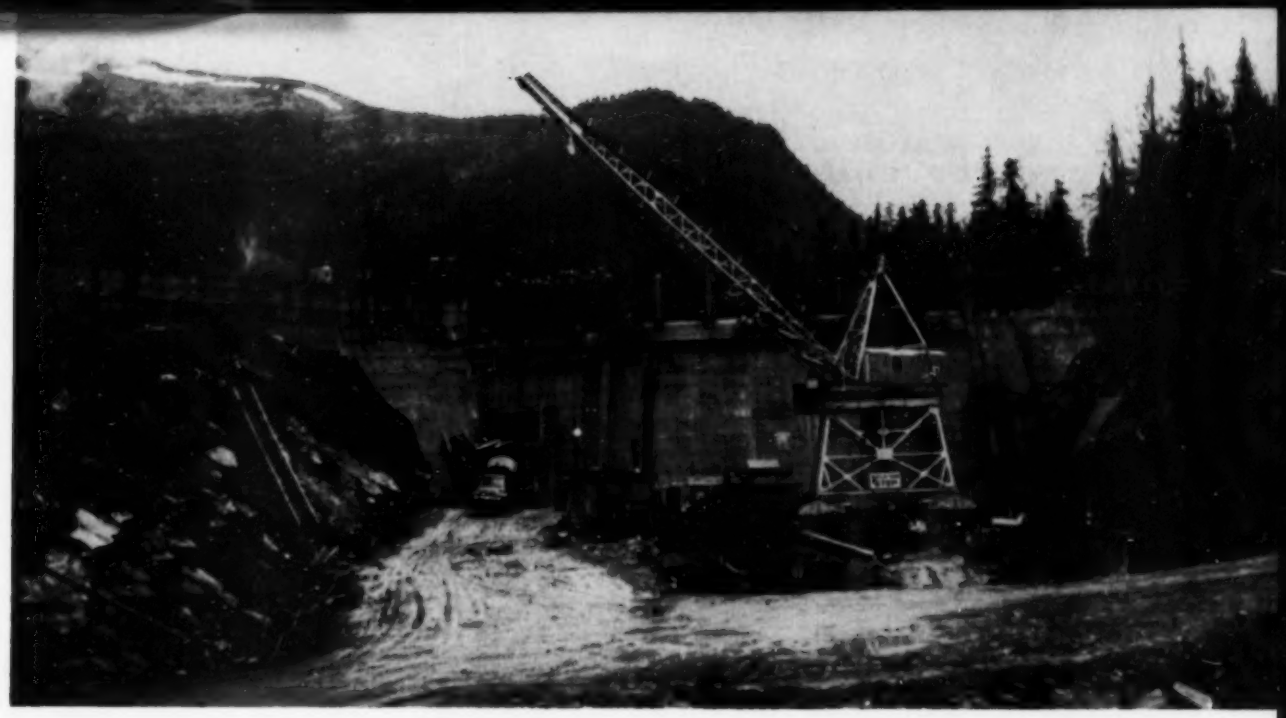
Pipeline intake

The intake to the wood-stave pipeline, which runs from the forebay to the water treatment plant at the mill site, is one of the interesting parts of the dam. This structure consists of a conventional trash rack provided with a trash rake for easy removal of floating debris. This rake was considered particularly necessary since the reservoir area was not cleared of timber except for a small area just upstream of the dam. To provide continuity of flow, the intake was designed with two identical sections either of which has the capacity to discharge the maximum design quantity at reservoir levels above El. 206. Each section has an intermediate wall with three gated openings to permit selection of the withdrawal depth to obtain the best quality of water. Both sections are interconnected by a gated opening normally open. Two 30-in. cast-iron conduits extend through the dam, one from each intake section.

Each conduit has a gated cast-iron bell-mouth intake, and at its lower end, a 24-in. Dow disc-arm throttling valve with hydraulic expander for control of discharge into the pipeline forebay. One of these valves will be operated by an electric motor with automatic controls for maintaining a constant water surface in the forebay, while the second valve will be manually operated. A gated 48-in. sluice is provided from the intake to the spillway apron. Conventional stop-log grooves are provided immediately downstream from the intake trash rack, in the forebay ahead of the wood-stave pipe intake, and also downstream from the expanders.

The forebay is designed for the future installation of a self-cleaning mechanical screen to remove fine trash, and with a side spillway of sufficient capacity for the wide-open discharge of both conduits through the dam. The use of the forebay made possible a more economical design of pipeline and surge chamber. Use of the dissipated head at the dam for the generation of electrical energy was considered but found to be uneconomical.

The conduit from the forebay to the water treatment plant at the mill site consists of 12,630 ft of 60-in. wood-stave pipe, approximately



upstream face. Concrete for dam, totaling 27,700 cu yd, was batched and mixed at pulp-mill site and transported to dam in agitator trucks, which discharged into hopper used to fill 2- or 4-cu yd buckets.

1,760 ft of 48-in. wood-stave pipe, 490 ft of 48-in. steel pipe, and 1,740 ft of concrete-lined tunnel as shown on the plan, Fig. 1. A substantial part of the 60-in. pipe was laid on a constant slope of 0.0008 with all curves of approximately 275-ft radius. Although the topography is mountainous, it was found possible to obtain excellent alignment without excessive cuts or fills. Bridges were not required, all streams being passed through rock fills in concrete-pipe culverts.

Firm subgrade provided

A firm subgrade for the pipeline was provided throughout its length. All muskeg and other unsuitable foundation soils were stripped. All fills were constructed of rock placed in approximately 2-ft layers and compacted by the hauling and placing equipment. After the pipeline grade was completed, a gravel surfacing was added and the resulting road used for hauling concrete and other materials to the dam.

The pipeline right-of-way was cleared of all timber which, if it fell, would reach the pipe.

The wood-stave pipeline is constructed on wood saddles founded on cast-in-place concrete sills embedded in the roadbed. All wood staves and saddles were milled from dried selected Douglas fir, incised after milling and treated by a hot-and-cold dip process to obtain a minimum penetration of pentachlorophenol of $\frac{1}{4}$ in. on sides and edges, and $1\frac{1}{4}$ in. on ends. This is the first known application of this treatment process to a wood-stave pipeline of this size and length.

Originally four tunnels were planned. However, because of the great demand for rock fill, two of these were changed to open-cut construction. The two remaining tunnels were driven by conventional equipment to a minimum size of 7 ft × 8 ft, with an arch roof. These tunnels were concrete lined to finished interior dimensions of 5 ft 8 in. by 6 ft 8 in. with a circular arch roof.

A surge chamber of 16-ft inside diameter with emergency overflow was excavated from the rock near the upper end of Tunnel No. 2.

The Connell Dam and conduit is a part of the pulp mill installation of the Ketchikan Pulp Co., a joint project of the Puget Sound Pulp and Timber Co. and the American Viscose Co. Lawson Turcotte is its president, Erik Ekholm, its vice president, and Harold D. Cavin, A.M.ASCE, its chief engineer. Design and supervision of construction of the dam and conduit, to the lower end of Tunnel No. 2, as well as the preliminary surveys and studies for this part of the project, were under the direction of William D. Shannon & Associates. Contractors for the job were Ward Cove Builders, a joint venture of Howard S. Wright and Guy F. Atkinson, M.ASCE.

Substantial part of 60-in. wood-stave pipeline was laid on constant slope of 0.0008 with all curves of 275-ft radius. Muskeg and other unsuitable soils were stripped to provide firm subgrade. In spite of mountainous topography, good alignment was obtained without excessive cuts or fills. Right-of-way was cleared of timber.

A concept of unity and a look at the past

THOMAS A. MARSHALL, JR., Secretary, Engineers Joint Council, New York, N. Y.

Over the years, the engineer has become the symbol for precise work and accuracy. But in my research for this paper, I was amazed to discover the lack of accuracy, or clear delineation, of the elements of a subject of extreme importance to the entire engineering profession. I refer to what has been termed "the unity of the engineering profession."

Unity is subject to different interpretations. By unity, do we mean, for example, "absence of diversity," "uniformity," "a unity of sentiment," "unification," or "continuity without deviation or change"? I don't believe that unity in these senses is the kind we in the engineering profession want, or need, or can achieve. As I see it, there are two essential elements of engineering unity. The first is solidarity, meaning a community of interests, objectives, standards, and responsibilities that will permit our profession, as a group, to express its opinions, manifest its strength, or exert its influence as a unit in specific areas. An excellent example of this kind of unity may be found in the American Medical Association, frequently alluded to in discussions on engineering unity. Many doctors disagree with some of the policies and actions of AMA. Some doctors are not even members of AMA. It does, however, express the opinion of the medical profession as a group.

Second, there must be—and some may consider this as heresy—a recognition of the value of self interest, individual and organizational, as a motivating force. We cannot maintain a unity organization without the support of engineers; we cannot count on their continued support unless the unity organization includes among its primary aims, aiding the engineer to improve himself, and improving the professional climate for engineering. Let's face the facts. The American Medical Association and the American Bar Association are virile unity organizations primarily because they aid doctors and lawyers to develop themselves professionally.

Areas of unity

We might next consider the areas in which an effective unity organization might operate to achieve these goals. There are problems that are generally national in scope, that the existing societies individually are not in a position to handle. I would say that these problems fall into two broad categories. First, there are those that affect the individual engineer only indirectly, in much the same manner as they affect any citizen. These we might call national welfare or public service problems. Second come those that affect the individual engineer much more directly. These we might call professional problems.

Public service activities

In the first category are problems on which a small group of highly competent members of the engineering profession perform a much needed service to the nation on behalf of the profession. These problems and their solutions are most important. The history of accomplishments in this area is impressive. It can be found in the annals of the Engineering Council of the National Technical Societies of America, founded in 1917, and its heir, The American Engineering Council, formed in 1920. At the current time, this is one of the major areas of the activities of Engineers Joint Council.

Some examples of these national welfare activities are The American Engineering Council's study on "Waste in Industry" and its survey of commercial aviation in 1925. The latter resulted in the establishment, in the U.S. Department of Commerce, of the Bureau of Aviation, the forerunner of the present Civil Aeronautics Authority and Civil Aeronautics Administration.

Current examples are the contribution of Engineers Joint Council to the development of a sound national water policy as reflected in its report, "Principles of a Sound National Water Policy"; or the contributions of EJC through its National Engineers Committee on the Industrial Disarmament of Japan, or in the statement of EJC's Atomic Energy Panel to the Joint Congressional Committee on Atomic Energy, recommending changes in the Atomic Energy Act to permit the engineering profession to make its maximum contribution in the development of atomic energy for peaceful purposes.

Professional activities

Most members understand the necessity for these national welfare or public service activities. Many of them, however, find these insufficient as a rallying point for their own enthusiasm. Unless we pursue activities that will help individual engineers to develop themselves professionally, they, in turn, will not support, or provide the grass roots backing through the technical societies so necessary for the continuity of any successful unity organization. For this reason, if for no other, we must be concerned with problems in the professional area.

I have in mind, for example, such activities as the accrediting of en-

This article is the first of two by Mr. Marshall dealing with the vital question of unity which is currently being widely discussed by many members of the profession. In the second article, to appear next month, he will speak more specifically of the organization of Engineers Joint Council and its activities in behalf of the profession to date.

gineering curricula, the development of standards of ethics, the development of adequate minimum registration requirements, progress toward uniformity of registration, and the like. Also in this area are studies on the relations of the engineer with his employer, and the related studies of engineering income, supply and demand.

The Engineers' Council for Professional Development has done a noteworthy job in developing engineers, from the time they begin to think about engineering in the secondary schools right through until five years after they receive their baccalaureate degrees. It has become the recognized accrediting agency for engineering curricula in the colleges and universities. It has developed canons of ethics that have set the pattern for ethics in the entire profession.

The now classic report of Engineers Joint Council, "The Engineering Profession in Transition," published in 1946, is another example of what I term a professional area activity. We might also consider the activities of the EJC Engineering Manpower Commission and the National Society of Professional Engineers in their efforts to improve the utilization of engineers, and to provide basic information of value to employers of engineers and to engineers in the resolution of their mutual problems relating to working conditions. Another example is the activities of the EJC Labor Legislation Panel, which was most successful in having the current professional provisions written into the Labor Management Relations Act of 1947—the Taft Hartley Act.

Still a further example can be found in the joint efforts of EJC and NSPE in successfully having the engineer employee practicing his profession exempted from the provisions of the Salary Stabilization Act.

Public relations

Related to both professional activities and national welfare activities is the necessity for an overall public relations program. A successful public relations program will be a partial solution, at least, of the problem of recognition of the engineer by those outside of the profession.

While the problem of recognition needs a considerable amount of effort behind it, there is progress being made in this area too. Through the efforts of EJC and its committees there has been a rapidly growing appreciation of the engineering profession in the Congress.

Previous unity efforts

Now I would like to consider briefly the most notable previous unity effort, The American Engineering Council of the Federated American Engineering Societies, established in 1920. It functioned through a council and an executive committee. The Council was composed of representatives of member societies on the basis of one representative for each thousand members. Membership ranged from a low of 19 societies (7 national, 5 state, and 7 local societies in 1932) to a high of 54 (8 national, 18 state, and 28 local societies) in 1940, the year it was dissolved.

The executive committee or administrative board, was composed of 30 members. Actually, it was an unwieldy organization inasmuch as a two-thirds affirmative vote was required in all decisions affecting policy or action.

Financial support came from assessments of member organizations. Although its membership was national, regional, and local, financial support came primarily from three national engineering societies: The American Society of Mechanical Engineers, American Institute of Electrical Engineers, and after 1929, American Society of Civil Engineers. Annual contributions from these three organizations accounted at times for as much as 95 percent of AEC income, and never amounted to less than 75 percent.

History of AEC prepared

A brief history of The American Engineering Council was prepared by A. F. Bochenek in 1951 after an exhaustive study of the old records of AEC. Mr. Bochenek, a member of the editorial staff of ASME at the time, says in his introduction, "Among those who were active in AEC affairs, there seems to be no unanimity of opinion why the AEC, after the signal achievements of the 1920's, failed to sustain the high level of interest in unity among member engineering societies that was so evident when it was launched during the postwar days of World War I."

Having pointed already to what I believe to be one of the major reasons for its failure—organizational (and financial) defects, I would like to offer another possible answer—imbalance of program. To support this, I quote further from Mr. Bochenek: "While the AEC did serve individual engineers who asked for aid and information, most engineers regarded it as a remote organization working in an indirect and intangible way for the betterment of their profession." When we look at the success enjoyed by ECPD (Engineers' Council for Professional Development) in comparison, we note immediately the concentration on activities in what I have called the professional area.

The services to members of the engineering profession rendered by the AEC were confined largely to two major activities. AEC maintained a roster of more than 115,000 names and records about engineers. This information was conveniently accessible to government departments and commercial interests. Secondly, it was instrumental, in 1935, in encouraging the Bureau of Labor Statistics to conduct a comprehensive survey that for the first time provided reliable information on engineering salaries on a profession-wide basis.

What we can learn about unity

In summary, I believe we can learn two things from the failure of the American Engineering Council. First, the views of the members of our profession must be thoroughly considered in developing the policies of any effective unity organization. The organization must also be designed to provide for effective executive action in line with these policies, but without the necessity for continual referral back to the constituent members or affiliates. The organization must be so tempered that it will not be subject to violent fluctuations of opinion.

The second thing to be learned is even more important—the effect of imbalance of program. The efforts of AEC were concentrated primarily on national welfare activities.

Reclamation of saline waters by electrodialysis shows promise

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All over the world, alike among underdeveloped arid nations and in highly developed countries, there is an insatiable demand for water. Civil engineers are well aware of the fact that most of the earth's waters are unfit for human, industrial, or agricultural use. For centuries men have dreamed of extracting plentiful supplies of fresh water from the ocean and from brackish surface and underground waters. Although salt extraction methods are known, their high cost has prevented the construction of extensive saline water reclamation projects.[1] The benefits to be derived from such projects, from the economic, social, and military standpoints, are so great that large expenditures of money for research and development programs are amply justified.

Many private concerns are engaged in the development of processes and equipment for reducing the mineral content of saline waters. In addition, the governments of the Netherlands, France, Great Britain, and the United States are actively participating in research programs directed toward the perfection of processes that may become economically feasible for the reclamation of saline waters.

Available methods too expensive

Sea-water distillation plants have been installed in such places as Bermuda, Kuwait on the Persian Gulf, Aruba and Curaçao in the Dutch West Indies,[2] and at a number of U.S. Army and Navy posts where adequate natural supplies of fresh water have not been available. These plants generally employ multiple-effect evaporators[2] or vapor compression-distillation apparatus.[3] Costs of installation are high, with published values of approximately $7,000,000 per mgd of capacity.[3] Fuel and power costs generally range from 50 cents to over $1 per 1,000 gal of fresh water produced, exclusive of labor and amortization. Other methods such as ion-exchange, solar evaporation, crystallization, chemical precipitation, and freezing have been shown to be too expensive for practical consideration on a large scale.[4]

Development work by physical and organic chemists within the past few years has brought another process to the threshold of economic reality. Reports from Europe[4] and the United States have indicated that the process of electrodialysis may provide a more economical answer to the problem of reclamation of many surface and underground saline waters, and possibly even sea water. This article attempts to explain the process, its economics, and its potentialities in the field of civil engineering.

What is electrodialysis?

In broad terms electrodialysis may be considered as a method of using electrical forces to pull cations (Na^+, Mg^{++}, etc.) and anions (Cl^-, $SO_4^=$, etc.) through semipermeable ion-selective membranes, leaving water behind. The process utilizes the semipermeable properties of certain types of plastic membranes which permit only the passage of positive ions (cations) in parallel with other types of plastic membranes which will only pass negative ions (anions). Placing one of each of these membranes in a solution of sodium chloride, and imposing an electrical field upon the cell will lead to the action shown in Fig. 1 (*a*) and (*b*).

Sodium ions can pass through the cationic membrane, *C*, but not through the anionic membrane, *A*. Chloride ions are the opposite. The net result is that the electrical force applied at the electrodes, *E*, tends to free the water in the central compartment of both positive and negative ions (other than practically undissociated water). The increase of two positive ions in the left-hand cell adjacent to the cathode is compensated for by the reduction of hydrogen ions (taking up the electrons), resulting in the formation of hydrogen gas. Hydroxyl ions remain in the solution, which becomes increasingly caustic. Similarly, stability is achieved in the right-hand cell adjacent to the anode as the chloride ions give up their electrons and evolve as chlorine gas, or as oxygen gas is produced with an increase of acidity. These electrode reactions may be shown as follows:

$$\text{Cathode: } 2H^+ + 2OH^- + 2E \rightarrow H_2\uparrow + 2OH^-$$

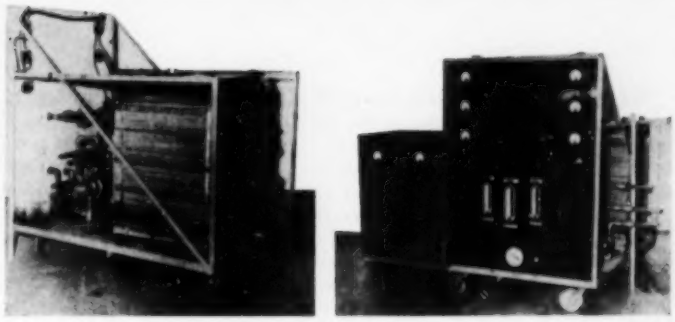
$$\text{Anode: } 2Cl^- \rightarrow Cl_2\uparrow + 2E;$$

$$\text{or } 2H^+ + 2OH^- \rightarrow O_2 + 4H^+ + 2E$$

Here ↑ represents a gaseous electrode product; → indicates the direction of the reaction; and E is an electron.

It will be noted that there are no reactions of the typical ion-exchange type. The membranes themselves are involved in the transport of ions and do not retain them. Hence no regeneration is involved. In practice, a simple cell such as is shown in Fig. 1 would be very wasteful to operate because the same current could pull many more ions through other membranes if they were placed in the path of the current between electrodes. Meyer,[5] Spiegler,[6] Langelier,[7] and others have suggested cells similar to that shown in Fig. 2. This shows four fresh-water compartments and five brine compartments. Electrodialysis units have been built and operated with over 100 such alternating compartments to achieve maximum operating efficiencies.

The secret of the successful development of electrodialysis as an economical process for the extraction of salts from water lies in the semipermeable membranes. Although electrodialysis is an old subject well known to biologists and chemists,[5] the engineering design of a membrane to fit into a structure capable of treating large quantities of water is another problem which has taken many years to solve. The characteristics of these membranes must include: (1) structural strength; (2) rigidity; (3) permeability to one type of ion only; (4) virtual impermeability to water; (5) reasonably low production cost; (6) insolubility in water over a wide range of pH; (7) resistance to abrasion by water of high velocities; (8) resistance to attack by bacteria and other micro-organisms in water; and (9) most important, high conductivity characteristics to keep power costs at a minimum.



Experimental electrodialytic unit, built and operated by Ionics, Inc., Cambridge, Mass., for U.S. Department of Interior,[11] has capacity varying from 15 to 300 gal per hr of desalted water, depending on salinity of influent and effluent, temperature, and current. View at left shows stack of parallel membranes about 20 in. × 20 in. Pumps, valves, and piping appear in both views. In view at right, rectifier for converting alternating current to direct current is seen at left of panel board containing flow meters, gages, and electrical meters.

These membranes are resinous materials which look and feel like solid sheets of plastic. In the gross physical sense they are solids. However, in almost all other respects they behave like solutions of electrolytes (organic bases or organic acids). The physical chemist describes them as "solid polyelectrolytes consisting of a hydrocarbon cross-linked skeleton to which polar groups are attached."[6]

Figure 3 shows a cation exchanger of the sulfonated polystyrene-divinylbenzene copolymer type, as envisioned by Juda.[8] The solid hexagon represents the benzene ring which serves to cross-link the hydrocarbon chains in every direction. The negative charge is bound into the matrix of the resinous material. It is represented by the large anion which has an SO_3^- radical at the end of a benzene ring, which in turn is attached to the hydrocarbon chain. Thus the motion of the anion is restricted.

On the other hand, the cations (sodium ions shown in Fig. 2) may be considered as being dissociated from the resin, much the same as a sodium ion dissociates from a chloride ion when salt is dissolved in water. Because of the electrostatic attraction of the negatively charged sulfonic ion, the sodium ion remains in its vicinity. These sodium ions (and other similar ions carrying a positive charge) are mobile and may move freely inside the resin, or into surrounding water under the influence of an energy source. Thus the cation exchanger shown in Fig. 3 may be classified as a semipermeable membrane since anions cannot enter, move, or leave the resinous material, while cations are free to move in any direction. Spiegler[6] has visualized this type of resin "as an anionic sponge filled with cations, the latter being replaceable by a mechanism similar to musical chairs." This is not a far-fetched idea, and it is one that may help engineers to understand the phenomenon of ion migration within the membrane. Figure 4 is an attempt to indicate what is involved.

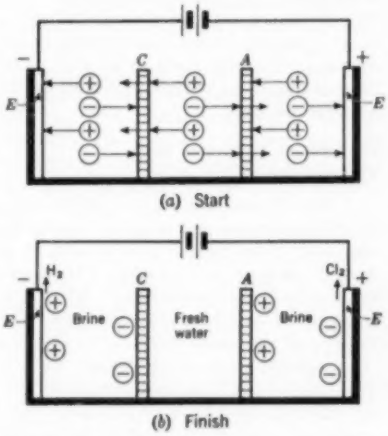


FIG. 1. Electrodialysis is action by which sodium ions (+) and chlorine ions (−) are extracted from water through cationic membrane (C) and anionic membrane (A) when electrical field (E) is imposed.

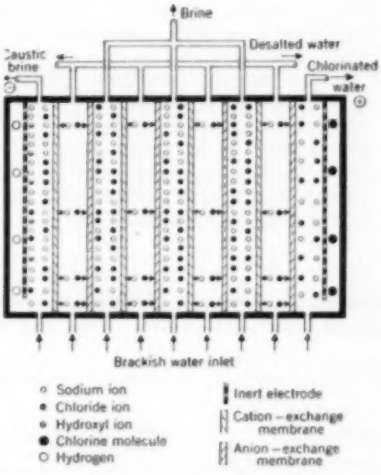


FIG. 2. Multicompartment electrodialysis cell, here schematically represented, is more efficient than single cell. Units with over 100 such alternating compartments have been built and operated to achieve maximum operating efficiencies.

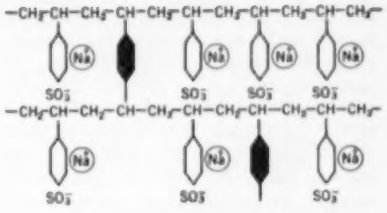


FIG. 3. In cation exchanger (solid, insoluble electrolytic conductor) of sulfonated polystyrene-divinylbenzene copolymer type,[8] solid hexagon represents benzene ring which serves to cross-link hydrocarbon chains in every direction. Negative charge, which is bound into matrix of resinous material, is represented by large anion which has SO_3^- radical at end of benzene ring, which in turn is attached to hydrocarbon chain. Thus motion of anion is restricted.

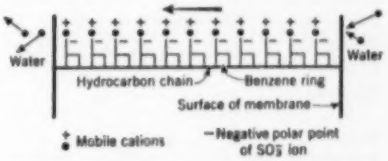


FIG. 4. "Musical chair" concept may help engineers to understand phenomenon of ion migration within cationic membrane. Ions having positive charge can move only from negative polar point to negative polar point—much the same as from chair to chair.

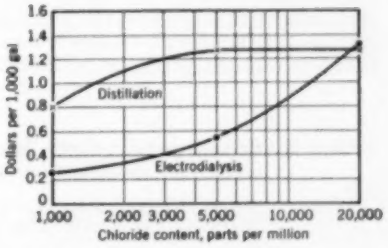


FIG. 5. Curves show comparative costs of desalting water of various chloride contents by distillation and by electrodialysis, at rate of 0.275 mgd to produce 500-ppm effluent. Sea water, which contains 20,000 ppm of chloride, is included here. Costs include fuel oil, electric power, amortization, and labor for hypothetical installation in Netherlands.[4]

When an electrical field is applied across a cationic membrane the mobile ions will migrate toward the electrode of opposite charge, the cathodes shown in Figs. 1, 2, and 4. Since the anions are tightly bound within the resinous matrix of the hydrocarbon chain skeleton, they cannot move under the influence of the electrical field. Anionic membranes are similar to those described above, with the exception that the mobile ion is the anion, such as chloride, sulphate, etc. In this case the cation is tightly bound to the matrix of the membrane, while the anions can go through, as indicated in Fig. 2. Within the past few years membranes have been perfected by Ionics, Inc., Rohm & Haas Co.,[9] and Permutit, Ltd.[10] These companies have reported that electrodialysis membranes are available commercially.

As of February 1954 a limited number of field installations of electrodialysis units have been made and operated on brackish waters and sea water. Most of these have been experimental units from which design data for larger field installations will be drawn. Ionics, Inc., has reported on a 100-gal per hr unit built for the U. S. Department of the Interior[11] and operated by Ionics to determine the effects of many process variables in the demineralization of brackish waters. A unit of this type is shown in the accompanying photographs.

Many factors enter into the determination of total membrane area, including initial and final salinity of the water, velocity and temperature of the water, current density, voltage, spacing of membranes, and efficiency of design and operation. Boer-Nieveld and Pauli,[12] working on the problem of reducing salt content of brackish underground waters in the Netherlands from 1,650 ppm to 500 ppm, have estimated that they would require 1 sq ft of each type of membrane per gallon per hour of water treated. With this design they were able to accomplish the above-mentioned desalting at a power requirement of 4 kwhr per 1,000 gal.

Juda, et al,[11] have studied the effect of membrane area per unit volume of water produced on power consumption for different types of saline waters. This study was based on the design of units to produce 75 mgd (10 acre-ft per hr) of water having a final salinity of 350 ppm. Table I presents these results. As in any other civil engineering design problem, the area chosen depends on the economics of the entire plant. A balance must be maintained between cost of power, which decreases with increase of membrane area, and cost of construction, which increases with membrane area.

Preliminary treatment and effluent disposal

Two major sanitary engineering considerations enter into the design of electrodialysis plants. The first is a water treatment problem. It must be recalled that membrane units are designed for the purpose of removing dissolved minerals constituting salinity. Many ground waters, as well as the ocean off shore, will not have any significant content of interfering substances. But if the waters to be desalted are surface waters containing turbidity, suspended and colloidal solids, and many microorganisms, a conventional water treatment plant may have to be used preceding the electrodialysis apparatus in order to prevent fouling of the membranes.

The second design consideration is a water disposal problem. Alternate cells shown in Fig. 2 produce concentrated brines which may amount to from 10 to over 50 percent of the desalted water, depending on many operational factors. With sea water this would not lead to a waste disposal problem. But on an irrigation project where 75 mgd of fresh water is produced, the waste brines may be over 10 mgd. Disposal of brine may have to be done by returning the waste water into the ground by means of deep wells, similar to procedures adopted by the petroleum industry.

Desalting costs

Greatest interest in the use of the membrane type of electrodialysis unit is for the desalting of brackish waters. Construction and power costs are a function of the degree of removal of salinity and therefore these costs are lowest for brackish waters. In contrast, the costs of evaporation and distillation are virtually independent of salt concentration. Under the auspices of the Organization for European Economic Cooperation, which includes the major countries of Free Europe, a study was made of the relative costs of desalting waters of various salinities by means of distillation and e'ectrodialysis. Their conclusions have been reported as follows:

"That the electrodialysis method appears to be the most economical way of desalting water is one of the conclusions reached after two years of study on this problem in Europe. This would apply for water with 1,000 to 5,000 parts per million of chlorides. For the treatment of sea water, the distillation and electrodialytic method are more or less competitive, whether the amount of water is in large or small quantity . . . . For the distillation method only marginal improvements may be expected, but electrodialysis is very new and great improvements are conceivable."[4]

The results of one phase of the study, covering a flow rate of 275,000 gal per day for a hypothetical installation in the Netherlands, are shown in Fig. 5. The significance of electrodialysis is obvious.

A concept of the energy requirements for various membrane areas may be obtained from Table I. Using the optimum membrane area in

TABLE I. Energy requirements for desalting various waters using different membrane areas

Design of plant is based on 75-mgd capacity (10 acre-ft per hr). Final effluent has 350 ppm salinity

Category of Water		Kwhr per 1,000 gal		
		Membrane area, sq ft per gal per hr		
Geographical source	Salinity, ppm	0.33	1.0	3.3
South Dakota	885	0.88	0.27	0.088
Arizona	4,635	35	10.5	3.5
Texas	10,000	153	46	15.3
Ocean	35,000	1,600	480	160

TABLE II. Investment costs of desalting brackish waters by electrodialysis

To secure effluent of 350 ppm at flow rate of 10 acre-ft per hr (75 mgd)

Equipment and Accessories	Investment Cost—Dollars		
	Salinity of water, ppm		
	885	4,635	10,000
Membranes and spacers	$ 440,000	$ 4,400,000	$ 8,850,000
Electrodes	20,000	150,000	300,000
Pumping station, piping, fittings	370,000	1,160,000	1,900,000
Building and heating	150,000	1,600,000	2,700,000
Rectification and wiring	660,000	2,580,000	5,650,000
Frame and insulation	50,000	370,000	1,070,000
Instrumentation	50,000	200,000	300,000
Total plant costs	1,640,000	10,400,000	20,770,000

each case, Juda[11] developed the cost analysis shown in Table II for the desalting of 75 mgd of saline waters (10 acre-ft per hr). These estimates are tentative, based on limited operating data, but they do present a picture of costs, including the necessary auxiliary equipment.

Estimated operating costs for these units are presented in Table III. The assumptions on which these estimates are based include power at 0.3 cent per kwhr and basic desalting unit costs at $25 per cu ft of stack volume. Amortization was based on a period of 10 years for the desalting units and 40 years for the auxiliary equipment, exclusive of maintenance and repairs.

Another cost analysis is shown in Table IV. This has been provided by Boehner[13] on the basis of preliminary work done in this field by the Permutit Company. This analysis assumes several categories of water. It is based on the production of smaller quantities of water for potable uses, rather than the larger quantities for irrigation, as cited above. All reductions of salinity are carried down to 500 ppm, the upper limit of salinity desired for potable water supplies. In this table it is assumed that a ground-water supply, suitable for direct electrodialysis, is being desalted. The investment cost includes the membrane units, piping and auxiliary equipment, except pumps. Annual cost of operation includes power and replacement of membranes, but no pumping, labor, or amortization charges.

The Conservation Foundation has envisioned the use of electrodialysis units for the irrigation of 208,000 acres of land adjacent to the sea. This would require the desalting of 1 billion gal of sea water per day (3,000 acre-ft per day) down to a salinity of 1,000 ppm. Total plant construction costs have been estimated at $280,000,000. This is equivalent to $280,000 per mgd of capacity, or $1,350 per acre of irrigated land. Operating costs, including amortization, labor, and replacement of membranes have been estimated at 32 cents per 1,000 gal, or $108 per acre-ft of water. Although much more pilot-plant work remains to be done before accurate cost analyses of such a large plant can be obtained or contract drawings prepared, these estimates do give a picture of the order of magnitude of the costs involved.

Good potentialities seen

Electrodialysis by means of semipermeable membranes appears to have genuine potentialities for the desalting of brackish waters, and possibly for the desalting of sea water. Much development work remains to be done before civil engineers will be in a position to make large installations for the production of water for domestic, industrial and irrigation purposes. The three major operating costs are for power, replacement of membranes and labor for maintenance and operation. As production of these membranes expands, their costs will probably be reduced and their lives extended. Further research may lead to higher loadings of the membranes in terms of greater salt removal per unit area, thus permitting a smaller investment at a somewhat increased power cost.

On the basis of the material presented in this paper it is estimated that plant costs will vary from $20,000 to $300,000 per mgd of capacity, depending on plant capacity and on the initial and final salt concentrations of the water being processed. Power demands can range from 0.1 to 200 kwhr per 1,000 gal of desalted water, but the usual range will be from 5 to 50 kwhr depending on the quantity of salt to be removed. It appears that the cost of a 1-mgd plant, designed to reduce the salt content of brackish water from 4,000 ppm to 400 ppm, can be built at a cost of $300,000 and can be operated at an estimated average cost of $0.60 per 1,000 gal, including the cost of power, membrane replacements, labor for operation and maintenance, and amortization.

In conclusion, it appears that this process holds forth hope that the reclamation of saline waters may soon come within the realm of practical reality, and that vast areas of water-deficient lands may be subjected to economic development. Electrodialysis is indeed worthy of the attention of civil engineers engaged in the fields of irrigation and sanitary engineering.

(This article was orginally presented by Mr. Eliassen as a paper at the ASCE Atlanta Convention before the Sanitary Engineering Division session presided over by Daniel A. Okun and W. N. Grune, members of the Division's Program and Publications Committee.)

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TABLE III. Operating costs per acre-foot for desalting brackish waters by electrodialysis

To secure effluent of 350 ppm at flow rate of 10 acre-ft per hr (75 mgd)

Cost Item	Operating Cost, Dollars per Acre-Ft		
	Salinity of water, ppm		
	885	4,635	10,000
Power for units	$2.56	$10.34	$22.60
Pumping	0.12	0.10	0.13
Labor and maintenance	0.50	2.00	3.09
Amortization	0.90	7.09	14.24
Total cost per acre-ft	4.08	19.53	40.07
Total cost per 1,000 gal	0.01	0.06	0.12

TABLE IV. Investment and operating costs for desalting brackish waters by electrodialysis

To secure effluent of 500 ppm (upper limit of potability) for various flow rates and salt concentrations

Influent Salinity, ppm	Flow, gal per hour	Investment, dollars	Power Cost, $ per 1,000 gal	Annual Operating Cost Operating 24 hr per day
5,000	300	$ 6,000	$0.09	$3,640
5,000	1,000	14,000	0.14	7,500
5,000	10,000	115,000	0.09	72,000
2,750	300	3,500	0.11	1,200
2,750	1,000	9,000	0.08	3,800
2,750	10,000	76,000	0.06	36,000
1,625	300	3,300	0.03	920
1,625	1,000	8,000	0.02	3,000
1,625	10,000	$60,000	$0.03	$19,500

Ground subsides in Houston area

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This investigation would not have been possible without the extraordinary cooperation of an unusually large number of engineers and geologists. Such cooperation is a heartening manifestation of the spirit of the very first rule of ECPD's Canons of Ethics for Engineers, which states that:

"The engineer will cooperate in extending the effectiveness of the engineering profession by interchanging information and experience with other engineers and students and by contributing to the work of engineering societies, schools, and the scientific and engineering press."

M.G.L.

Cause found to be declining artesian water pressure

The earth's surface is gradually sinking and tilting in a vital area of metropolitan Houston, Tex. This thus-far orderly disturbance centers in the industrial district near the inland terminus of the Houston Ship Channel, which connects the Port of Houston with the Gulf of Mexico. Many of the industries responsible for sustaining the phenomenal growth of the Houston region are situated in the affected area. Much of the rapid postwar expansion, especially in the petro-chemical-based group of industries, has been along this deep-water outlet to the sea.

Despite the exceptional economic importance of the area, relatively few people know that the land surface is sinking. And no one knows very much about the character of this regional subsidence, which has caused serious difficulties in recent years in connection with certain engineering surveys, particularly, in maintaining the integrity of leveling bench marks. This has resulted in all sorts of confusion in the affected area, where large-scale new construction, expansion, and reconstruction have been going on continually for several years. Much of this confusion has been attributed to other causes.

Subsidence along West Canal

It has been especially aggravating on engineering construction works where interrelated design grades or relationships must be maintained over considerable distances. This situation can be best illustrated by relating it to a specific project. Original levels for Houston's 14-mile West Canal were run in 1944 (Fig. 1). Six years later, these lines were rerun. This was for the planning of a canal lining and enlarging program, now under construction for the city's surface-water supply from the San Jacinto River. The lines were again

So far maximum subsidence has occurred in Pasadena area—about 3.5 ft. It is expected to be 7 ft or more by 1970. Area of maximum decline is circled.

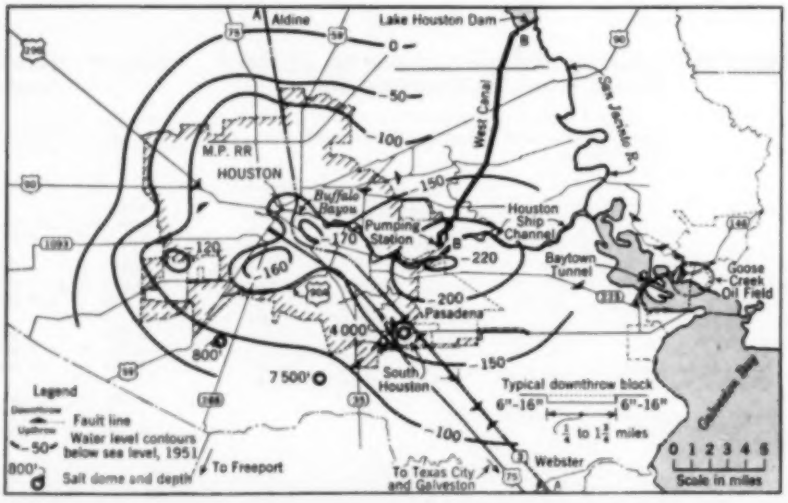


FIG. 1. Heavy withdrawal of confined ground water has caused cone of lowered artesian pressure to develop over most of Harris County, Texas, with accompanying subsidence of ground surface.

rerun in 1953. In the nine-year period from 1944 to 1953, the ground had sunk about 2.1 ft at the terminus of the canal, on the north side of the Houston Ship Channel. It is estimated that the subsidence at the beginning of the Canal at the San Jacinto River, for the same period, was only about 0.4 ft. All three sets of levels were run by my firm and under the same supervision. Fortunately, this tilting is in the direction which increases rather than decreases the canal's very flat grade.

Examples of more extreme subsidence

Mexico City is perhaps the best known example of an area where extreme settlement of buildings takes place as a result of consolidation of a highly compressible foundation soil of volcanic origin. Moreover, it is now a classic example of regional subsidence due to withdrawal of ground water. The city is being carried steadily downward, the present rate of settlement being reported as 11.8 in. per year, reportedly due to continued withdrawal of water from artesian wells. A 115-million-dollar rescue operation for a 30-year water supply has been suggested. It will include flood control and dams to augment the city's water supply. Also, recharge wells are proposed to restore some of the water which Mexico City has been withdrawing for centuries from its subsoil.

The Santa Clara Valley of California subsided a maximum of about 5.5 ft from 1912 to 1938, according to the National Research Council. This subsidence was roughly proportional to the decline in the water table resulting from withdrawal of ground water. The change in volume in the formerly saturated clay, now drained by pumping, is believed to account for the settlement. The sinking virtually ceased in 1937, three years after the well pumping operations were spread and the water level was raised 50 ft.

The Terminal Island (Long Beach) area in California was reported to have reached a maximum subsidence of about 13 ft, between 1937 and 1952, at the center of a subsidence which coincided closely with the center of production of an oil field. Ultimate subsidence was estimated at 18 to 23 ft. The Geological Society of America reported very close agreement between the relative subsidence of the various parts of the field and the pressure decline, thickness of sand affected, and mechanical properties of the oil sands.

The Texas City, Tex., area subsided a maximum of some 4 ft, mostly since the beginning of World War II, caused almost entirely by withdrawals of ground water from a limited area prior to the development of a supplemental supply from the Brazos River.

Subsidence in Houston area

Surface subsidence, with the greatest depth of the depression centered in the industrial region along the Houston Ship Channel, generally known as the Pasadena area, has been shown by first-order levels of the U.S. Coast and Geodetic Survey. This subsidence is reflected by the differentials between two lines of levels run by the U.S.C. and G.S. in 1943 and rerun in 1951. These show a maximum subsidence of about 1.5 ft during the eight-year period. See location of Section A-A in Fig. 1 and the profile of subsidence in Fig. 2.

The same general tilting of the ground surface has been closely verified by levels run along Houston's West Canal. As has been indicated, these show that the south end of the canal, near the Houston Ship Channel, between 1944 and 1953 subsided about 1.7 ft more than the north end, or start of the canal at the Lake Houston Dam on the San Jacinto River. See location of Section B-B in Fig. 1 and profiles of subsidence in Fig. 3.

An extension of the levels for the canal improvement, across the Ship Channel to the Pasadena area, indicates a total accumulated settlement of about 3.25 ft. This compares with the 2.1 ft of subsidence determined across the channel for only a nine-year period.

The subsidence has been accompanied by a more or less definite pattern of faulting, as shown in Fig. 1. These faults, ranging from about 6 to 16 in. in displacement, are easily located across the concrete pavements in the area. Most of the displacement of the various faults crossing the pavements has occurred since 1942.

Settlement of the ground surface in general has been caused by, or found in connection with, withdrawal of oil, gas, water, sulphur, and salt from the ground by wells. Great quantities of oil, gas, and water have been withdrawn from the Houston area and considerable salt has been taken out.

For a long time Houston was the largest city in the western hemisphere to secure its entire water supply from the ground. The estimated daily pumpage reported for public and industrial supplies in the Houston and Pasadena areas for 1950, 1951, 1952, and 1953 are 156, 167, 180, and 186 mgd respectively. This heavy withdrawal has resulted in the decline of artesian water pressure which is indicated by contours of water levels in observation wells in Fig. 1 and by profiles in Figs. 2 and 3.

Areas of particular interest are along the West Canal, around the business district, and in the industrial area along the Ship Channel. In these areas, the withdrawal of ground water has greatly exceeded the withdrawal of oil and other

FIG. 2. Subsidence closely approximates 1 ft per 100 ft of decline in pressure head, as shown by profile along line A-A in Fig. 1.

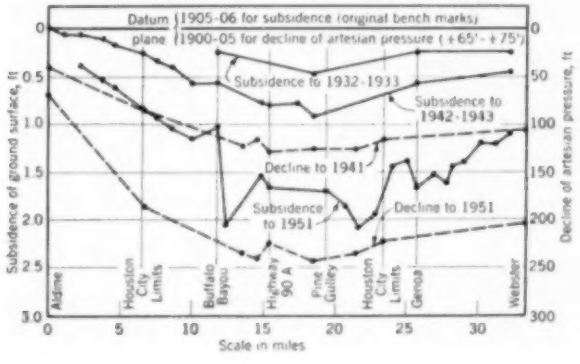
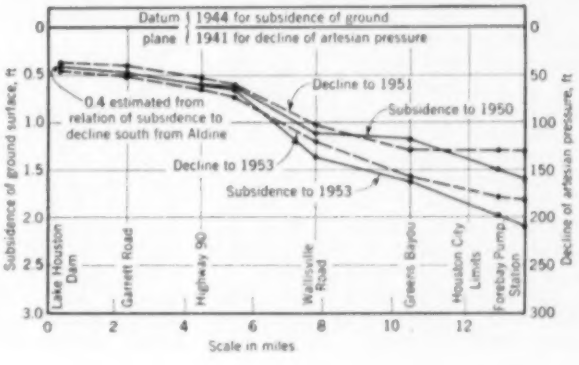


FIG. 3. Profile along 14-mile West Canal (line B-B, Fig. 1) shows subsidence of 2.1 ft at junction with Houston Ship Channel.



minerals. This fact, along with the remarkable relation, reported by the U.S. Geological Survey and the Texas State Board of Water Engineers, between ground subsidence and reduction in artesian pressure, has led to the conclusion that this reduction in pressure is the most logical cause of the major part of the subsidence in these particular areas.

Due to decline of artesian pressure

The relation between the subsidence of the ground and the decline in artesian pressure is shown in Figs. 2 and 3. By plotting 1 ft of subsidence to the same scale as 100 ft of decline in pressure head, a very close relation of 1 ft of subsidence per 100 ft of decline is shown in Fig. 3, for the years 1944–1953 along the West Canal. This is the same relation that Allen G. Winslow and W. W. Doyel, geologists with the U.S. Geological Survey, found and reported in an as yet unpublished bulletin, along Section A-A (Fig. 1) between Aldine and Buffalo Bayou, between the years 1942 and 1951.

Total accumulated subsidence and decline with reference to possibly uncertain bench marks and original artesian pressure are shown in Fig. 2. This indicates that the relation of total subsidence to total decline is somewhat less than 1 ft per 100 ft. This is tentatively attributed to some preconsolidation in the soils, particularly the clays, due to compaction by desiccation. James P. Sims, A.M. ASCE, has stated that in foundation studies it is generally found that the shallow clays have been subjected to a preconsolidation load of from 3 to 4 tons per sq ft.

Geologically, however, these soils are considered to be unconsolidated because there has been no thick deposition and subsequent erosion of material above the present ground surface. Consequently it appears that the first 65 to 100 ft of decline will cause little subsidence. Then a greater decline causes a higher comparative rate of subsidence.

Analysis and interpretation of available information on this complex subsidence phenomenon, by authorities on soil mechanics and geology, indicates that it is largely due to consolidation of the soil arising from reduction in artesian water pressure. To some extent, however, it probably is due in parts of the area to the superposition of subsidence from declining gas pressure, or related hydrostatic pressure, in the oil fields.

The artesian pressure in the Pasadena area is declining at the rate of about 100 ft in 8 years. At that rate, the pressure level will have fallen to about minus 450 ft before 1970. That is the approximate elevation of the top of the major aquifer in a representative well in the area. Thus, there is reason to believe that within the next 15 years the earth's surface in the region of maximum disturbance will have subsided twice as much or more than it has to date. This estimate of future subsidence compares reasonably well with a theoretical determination made by a rather oversimplified consolidation analysis which necessarily employed assumed values for the mechanical properties of the soils.

The ground elevation loss is permanent. There could be little rebound, even with conceivable but wholly improbable restoration of original artesian pressure. Actually, at any given time, the subsidence can be halted only by an increase in artesian pressure.

Known or suspected difficulties induced by subsidence in the Houston area have not been very serious to date. Fortunately the major faults have not occurred in areas occupied by important structures. Some minor differential settlement has resulted in the cracking of certain building walls. Revision of plans for canals, roads, and drainage systems has been made necessary by the subsidence. The loss of ground elevation in areas of maximum subsidence already has wiped out the normal freeboard allowance for flood and hurricane tides.

Future trouble can be serious

More serious trouble may be expected in the future if this subsidence continues at the present rate or increases. Up to the present, neither uniform nor differential subsidence has received much, if any, detailed consideration by designers and builders. The time has come, however, for responsible management to have its planners, designers and constructors recognize the significance of the subsidence factor in all important future undertakings in the affected area.

More care should be exercised hereafter in placing wells adjacent to concentrated industrial or other high-value developments, buildings, wharves or other structures. This is especially important if the wells are of such depth, and in such soils that abrupt local cones of subsidence might be formed.

New buildings should be located clear of known surface fault lines or they should be designed for differential settlement. Elevated tanks ought not to be located too close to wells producing from shallow depths. Where pressure differentials or tilting would appear to be in prospect, special care should be taken in the design and routing of surface drainage, sewers, water and other underground utilities.

To cope with this subsidence problem, there must be a reduction in the excessive rates of withdrawal of ground water in the critical areas. This would entail dispersion of well fields and much increased use of river water in the future.

Ample sources of good water are available for all foreseeable future municipal and industrial requirements in the Houston area. Supplies entirely satisfactory in quantity and quality can be developed at reasonable cost from ground and river sources, in such a way as to minimize the subsidence pitfalls of the future. The incremental cost of transmission to heavily developed areas, from properly situated well fields and from rivers, might prove to be less in the long run than the unhappy alternative of serious property damage in the subsiding area.

Such conclusions as have been reached here have been made possible only by the most dogged and determined gathering of information from widely scattered sources. The present need is for more data, more study, more knowledge and more technical and lay interest in, and discussion of, this subject. All these things are needed to provide a basis for really dependable estimates of future rates and ultimate amounts of subsidence, and to assist in forecasting possible abrupt and destructive differentials.

Compilation and interpretation of available information on this complex regional subsidence required knowledge and experience which I did not possess, especially in soil mechanics and geology. Accordingly, the services of qualified authorities in these fields were enlisted. H. P. Carothers and Spencer J. Buchanan, Members ASCE, collaborated in the soil mechanics aspects and each gave comprehensive consideration to the whole problem. Paul Weaver, Member AAPG and AIME, supplied much of the geological analysis. In large part, technical interpretations and conclusions reported here are directly based on the work of these outstanding specialists, modified to some extent by critical reviews afforded by other such competent authorities.

(This article is based on the paper presented by Mr. Lockwood at the Spring Meeting of ASCE's Texas Section in Midland, Tex.)

Applied engineering principles reduce costly accidents

WILLIAM A. LUNA, M. ASCE, Senior Safety Engineer, Liberty Mutual Insurance Company, New York Division

According to the National Safety Council, in 1953, about 2,500 persons were killed in accidents and 218,000 were injured in the construction industry. In other words, every day of that year eight persons were killed and 73 were injured on construction work alone. This probably represents a loss of not less than 3,500,000 man-days. Such a record is a definite challenge to the industry if only for humanitarian reasons. However, if a sound, workable solution for this problem is to be found, it must be approached from the practical engineering point of view. The construction industry is concerned with many fundamental engineering principles, not the least of which are those within the province of the safety engineer.

From the point of view of insurance costs, an interesting fact emerges—that a high accident rate can be a real factor in competitive bidding. The mathematical relationship between expected losses and computed premiums is, of course, an actuarial problem. This is a subject in itself. For our purpose here, it is only necessary to realize that construction involves a certain risk. This risk, which may be regarded as a measure of exposure to accidents, is substantially a controllable factor, which is dependent upon the loss prevention activities instituted and applied by management.

A contractor pays premiums for compensation according to the manual rates established by the State Rating Board. If his losses at the end of the year are below expectations, he will enjoy a credit. If his losses are above expectations, he will suffer a loss, known as a "charge." This variation in rate below or above the manual rate is a measure of his "experience" which affects the "adjusted" rate. A high charge can be a real factor in competitive bidding.

Consider a hypothetical structural steel erection job, on which the engineer's estimate is assumed to be $100,000. The following figures and corresponding insurance cost have been simplified for clarity. The breakdown between overhead and profit may be roughly as follows:

Overhead	9 percent, or $9,000
Profit	8 percent, or $8,000

Taking the compensation manual rate for structural steel as $24 for every $100 of payroll, the insurance cost is computed at $4,150. Under these circumstances it would be possible for one contractor to enjoy a credit high enough so that his adjusted insurance rate would bring the cost down to around $1,580. Another contractor bidding for the same job might be compelled to assume an adjusted insurance rate such that his cost would be around $8,230, thus sacrificing a good part of his profit, and placing himself in an unfavorable competitive position.

The contractor pays

The actual cost of accidents to the contractor is well over four times the compensation cost. This minimum ratio was arrived as through an extensive study made by the Associated Contractors of America. A few cases will serve as illustrations.

Case 1. Monolithic pouring operations were under way on the arch of a rigid-frame reinforced concrete bridge. The contractor's design of forms called for 8 × 8-in. posts, 16 to 18 ft long. However, because he did not have this size, he decided to use 14- to 18-ft lengths in conjunction with short pieces to make up the required height. The butted joints were made fast with scabs on one side only, with no lateral bracing connecting the short pieces of adjacent posts. During the pouring operation, the lateral thrust, built up by the freshly poured concrete in the arch haunches, caused the column joints to topple, whereupon the entire form collapsed. As a result, 10 men received minor injuries costing $100. This represented the cost to the insurance carrier. However, it cost the contractor $17,000 before he was in a position to start pouring again.

Case 2. While working on the construction of a shipway, a dock builder fell off a stringer, dropping 18 ft to the ground. An ambulance was instantly called. Sixty men crowded around the injured man for almost an hour, until the ambulance arrived. It was later learned that the man was not seriously hurt. The total cost of the insurance was $35. However, the cost to the contractor through the loss of a total of 60 man-hours of production and loss due to idleness of heavy equipment, was estimated to be $150—a ratio of over 4:1 against the contractor.

Case 3. The ventilation system on a mile-long rock tunnel project delivered 5,000 cu ft per min of fresh air to the tunnel heading. This amount of air in a tunnel with a 750-sq ft cross-sectional area was proved to be inadequate at the very start of the job. Gasoline- and diesel-powered equipment was in constant use in the tunnel and 1,000 lb of dynamite was used every day. A steady stream of tunnel miners had to be given first aid necessitated by equipment and blasting fumes. Two hours out of every 24 were required to clear the tunnel heading of dynamite fumes. Fifty miners had to remain idle for these two hours. By even a conservative estimate, the production losses incurred amounted to many thousands of dollars.

In the manufacturing field, operations are basically repetitive, so that any phase of production can be observed at any time. The operation observed today was precisely the same yesterday and will be the same tomorrow. But in the construction industry, the constantly changing phases of operations offer an entirely different problem. To this must be added the obvious fact that no two projects are ever exactly alike even though they may be similar.

If the contractor could purchase new equipment especially suited to each project, and if he could select the site for each job to insure ideal working conditions, he could design the construction methods with a high degree of perfection on each job. But of course this is not possible.

For instance on a building construction job, foundation design can by anything from spread footings to caissons or piles. The type of framing, either steel or reinforced concrete, will affect the contractor's construction operations. The plan, size, and height of the building will vary, as well as the type of exterior—whether brick, stone, or aluminum.

Advanced analysis essential

Obviously many problems have to be faced before anything can be done to assist the contractor in the prevention of accidents. In the study made by the Liberty Mutual Insurance Company to determine the best way to render such assistance, it was found that the proper engineering approach depends, in great measure, on the knowledge and experience gained from association with a vast number of construction jobs. It was discovered further that the most important fundamental of this engineering approach is the determination of potential accident locations before operations begin. As a result, what is called an "advanced analysis" has been developed. This involves the careful study of each phase of an operation while it is still in the planning stages, including the study of movements, structural analyses, and even the forces of nature.

The concept of the advanced analysis was developed from the study of reports of thousands of accidents and phases of operations in which they occurred. From this study a series of steps for determining accident-producing conditions and their locations evolved, taking into account the necessary safe flow of operations.

In general, these steps fall within two groups:

1. Study of the job during the planning stages to discover accident-producing conditions.
2. Application of the needed corrective measures as revealed by the studies.

While the equipment and materials used are reasonably common to all jobs, there is no set pattern for their use that is followed by every contractor. Furthermore, even where two jobs are generally the same, there will always be differences between them in both design and method. It follows that the accident-producing conditions will vary accordingly. Therefore, in order to discover any accident-producing conditions within an operation, a knowledge of *how* that operation is to be performed is a necessary prerequisite. It is also necessary to review the contractor's construction method and procedure before preparing the study.

One of the greatest advantages of the advanced analysis method is the fact that it not only aids the contractor in laying out his work safely, but helps to reduce the tendency to evaluate the job on a day-to-day basis.

The study of recorded data leads to the determination of the accident-producing conditions. When properly carried out, these studies will clearly indicate basic accident causes (Fig. 1). These studies are then offered to the contractor so that he can take the necessary steps to apply them to the job. He can distribute copies of the analyses among his supervisory personnel, as part of an educational program toward a logical, practical engineering approach to accident prevention. It is interesting to note that in the past few years, this approach has received increasing interest and cooperation from our contractors.

Accident groups

From hundreds of advanced analyses, four basic groups of accident-inducing weaknesses have become apparent.

The first general group is uncontrolled contact or interference between men and material, or between men and equipment. Obviously where conditions are static no accident will occur except, of course, through an act of God. The introduction of dynamics, as represented by movement, such as congestion, cross-overs of men and equipment, high-speed free-swinging loads, material storage areas, and truck routing, provide accident-producing conditions.

The second general accident-inducing factor is failure of temporary structures such as forms, scaffolds, ramps, ladders, cofferdams, or sheeted cuts. Whenever any of these are inadequately designed, failure or collapse is possible. A frequent condition, which is often ignored, is the high stresses that materialize during construction. It is not unusual to find that, although the design may indicate a factor of safety of 3, 4, or more, the actual field stresses reduce or destroy any safety factor provided. For example, in the design of cofferdams, it is essential to consider the high stress developed in the sheeting *before* the last ring has been placed.

The third general grouping is inherent engineering hazards. Perhaps the most important of these results from the use of explosives. Others arise from the presence of injurious gases and toxic dusts. Whenever explosives are used, there is always the possibility of premature explosion or misfire as a result of negligence. In

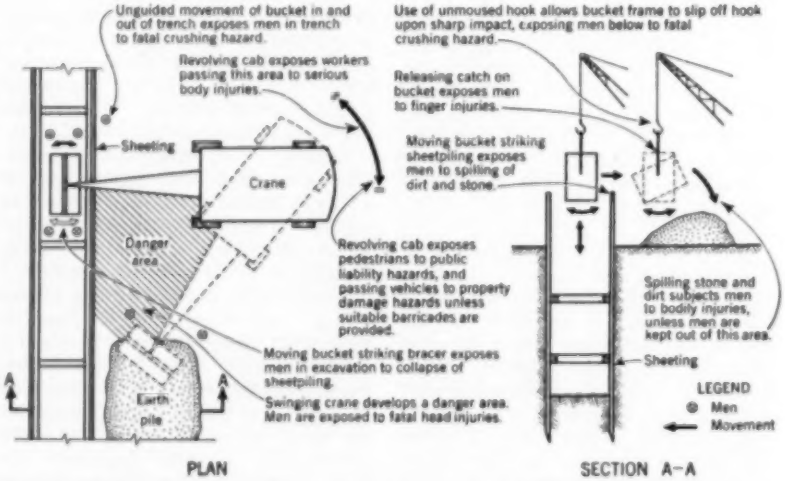


FIG. 1. Diagrams are essential for adequate accident analyses. Here danger points in pipe-laying operation are graphically shown on schematic layout. Operation consists of lowering bucket by crane into trench between braces; filling bucket by hand shovels; lifting bucket out of trench, swinging it over, and lowering it in adjacent area; releasing catch on lip of bucket by worker to dump load; and securing catch on emptied bucket.

confined operations such as tunneling, accumulations of gases from the use of gasoline or diesel-powered equipment, if such are used, may cause serious pulmonary injuries. The exposure, of course, varies with the efficiency and capacity of the ventilation system. During extensive rock drilling, any uncontrolled accumulation of dust becomes a serious inherent hazard.

The fourth and final group of accident-inducing factors involves unsafe practices of individual workers, or personal hazards. Although accidents in this group are generally minor in nature, their frequency of occurrence is often high. Control of accidents in this category is a matter of education, which is the responsibility of management. One of our functions is to assist contractors in developing safe practices commensurate with the type of construction.

This then is a general outline of the advanced analysis. Following this analysis the studies are carried further by including the application of fundamental engineering principles through the use of specially designed instruments. These instruments assist in the detection of inherent failure points. Two of these instruments which have proved of great value will be described. It is important to keep in mind, that if a contractor wants a safe job, two things must be done; (1) the forces produced by the method of operation must be determined, and (2) they must be determined in advance of the operation, for a partial or total failure may produce severe or fatal injuries, not to mention damage to property, and cost to the contractor.

Blasting and pile-driving operations are always associated with possibilities of damage to adjacent structures. We have therefore designed a sensitive instrument called an accelerograph. (See "Ground Vibrations Due to Blasting and Its Effect Upon Structures," F. J. Crandell, Assistant Vice President, Liberty Mutual Insurance Company.) The accelerograph measures vibrations in the ground during construction operations. We are interested in whether or not vibrations from blasting or pile driving can cause damage to nearby structures and if so, how we can limit or control the damage through the contractor's method.

The intensity of ground vibrations can be used as an indicator of structural damage, provided that the structures are composed of standard engineering building materials that have not been prestressed.

This instrument measures the magnitude and direction of forces transmitted through the ground. Our present recording accelerograph was designed to measure the accelerations in three planes. Three reeds are placed in the vertical, transverse, and longitudinal planes, which are activated when vibration occurs. Mirrors attached to the reeds pick up light sources which are transmitted as light beams to a film in motion. The saw-tooth curve for each of the three planes indicates the frequency and amplitude, which are then measured with a caliper. These measurements become the basis for computing the developed "energy ratio." The energy ratio is a function of accleration, a, and frequency, n. It is derived from the basic kinetic energy formula,

$$KE \frac{WV^2}{2g}$$

from which it can be shown that this can be reduced to give a value in terms of acceleration, that is,

$$KE = \left(\frac{W}{2g\,4\pi^2}\right)\left(\frac{a^2}{n^2}\right)$$

The first fraction of the equation is a constant for any location, depending upon t' e mass. For practical purposes it is of interest to us to establish a relationship between the number of pounds of dynamite in the vibration source and the energy ratio developed. The empirical equation established is

$$ER = \left(\frac{5 \text{ deg}}{\text{Distance}}\right)^2 = C^2K$$

where C is the number of pounds of dynamite, and, K is the earth characteristic set into vibration. Therefore, if the mass is constant, the kinetic energy may be considered proportional to $\frac{a^2}{n^2}$, which is referred to as the energy ratio. Experience indicates that if the energy ratio is kept below 3, no damage will be done to buildings of sound construction.

In the rock excavation for the subway escalator along the Chanin Building in New York City, the energy ratio developed was under 1.5. As a result, there were no appreciable claims for damages. On the other hand, readings taken on a rock blasting job in Canada indicated energy ratio readings in excess of 6—over twice the tolerable limit. Claims for structural damages on this job were nearly $100,000.

When deep-trench excavations are made through cohesive materials, the contractor must know to what height a vertical cut can stand without support. By the use of the second tool previously referred to, the safe height of the vertical cut can be determined. This simple instrument, which we have developed, is an ordinary spring balance and a yoke to load a sample of the undisturbed material taken from the site (Fig. 2). The reading on the scale, taken at the point of failure in shear, gives the unconfined compressive strength. The formula for this is

$$P_c = W/A$$

where W is the scale reading at shear failure, and A is the cross-sectional area of the cylindrically shaped sample.

Further, it is known that there is a definite relationship between compressive strength and vertical height, as shown by the formula,

$$H_c = 1.33\,P_c$$

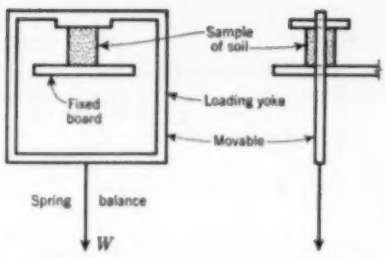
Because of the many variables involved, these formulas are not to be accepted as mathematically precise. They do, however, provide the contractor with a simple, practical and useful answer, which is sufficiently accurate to indicate whether or not sheeting is necessary.

In preceding paragraphs the part that the insurance company can play in the control of industrial injuries has been outlined. But this is not enough, since the employer himself is always the one who can do the most to control accidents.

Over 60 percent of accidents are controllable

A close study of basic causes of accidents reveals that most accidents are

(Continued on page 112)

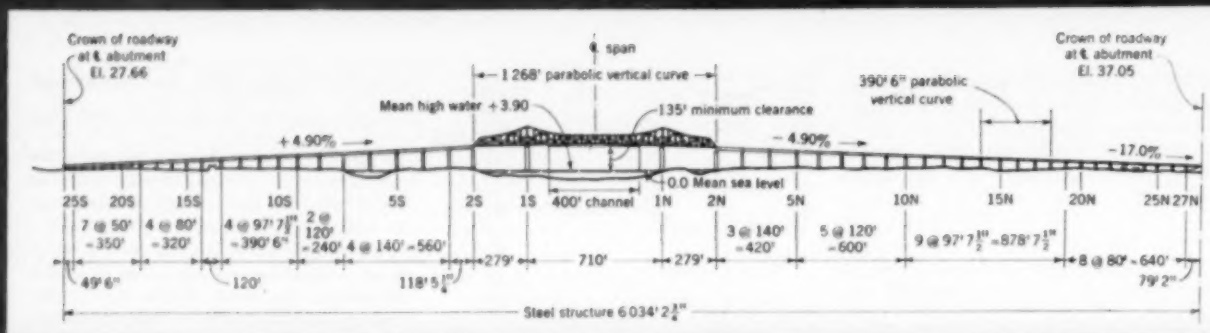


$P_C = \frac{W}{A}$

W = Spring balance reading at shear failure, in pounds.

A = Area of undisturbed sample of soil, in sq in.

FIG. 2. Simple soil-testing machine gives rough unconfined compression strength. Such data enable contractor to judge safe limit of unsupported vertical cut in cohesive soil.



High-level cantilever bridge spans

ALFRED HEDEFINE, M. ASCE, and THOMAS R. KUESEL, J.M. ASCE

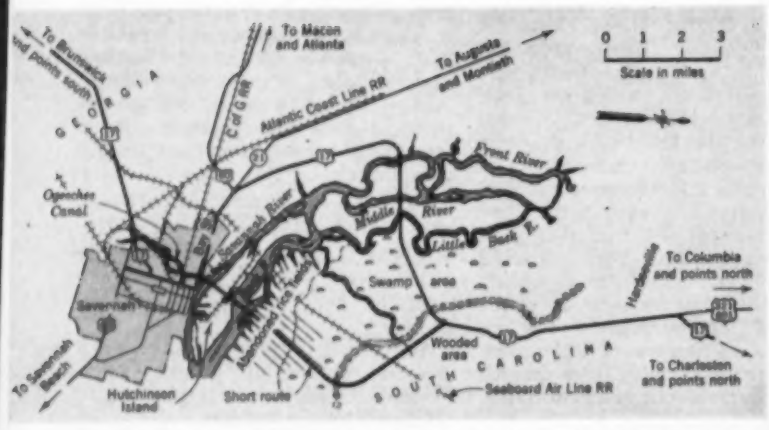


FIG. 1. Project extends southward from Route U.S. 17 in South Carolina, across Back River, Hutchinson Island, and Savannah River into City of Savannah. Connection to Route U.S. 17 at the Savannah end is being built concurrently but is not part of project.

Pile bents for concrete trestle across Back River are seen completed, with about half of concrete superstructure in place. Hydraulic embankment across swamp appears in distance, at top of photo.

Aerial view of main bridge structure shows progress made up to late February 1954. Steel has reached Piers 5 S and 5 N, and concrete-deck paving is well along on south approach. Looking north from Savannah across Savannah River to Hutchinson Island, south approach is seen to follow Ogeechee Canal between river and toll plaza in lower left corner of photo. Bay Street Viaduct, at upper left, carries existing Route U.S. 17 over Central of Georgia Railroad yards.

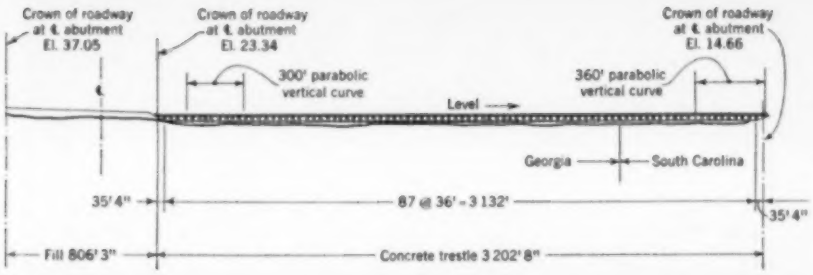


FIG. 2. Central feature of project is high-level cantilever truss span across Savannah River, with approaches of deck-plate girders and steel-beam spans stretching south into Savannah and north three-quarters of the way across Hutchinson Island. Interchange on north shore of island will connect with future roads which are not part of project. Interchange adjoins concrete trestle which crosses Back River northward to South Carolina.

Savannah River

Respectively Partner and Project Engineer, Parsons, Brinckerhoff, Hall & Macdonald, Engineers, New York, N.Y.

The nine-mile, $14,600,000 Eugene Talmadge Memorial Bridge crossing the Savannah River, which is being rushed to completion at Savannah, Ga., will eliminate an important traffic bottleneck on the Atlantic Coast Highway and realize a 30-year dream of a direct crossing to replace the present oxbow on Route U. S. 17. Over 5 miles of the project lie across water or swamps which range up to 40 ft in depth. The assortment of steel and concrete bridges and embankments which are required presented the engineers and contractors with a variety of problems. Not the least of these was the necessity for the design and construction to proceed concurrently in order to assure completion of the project within two years after the financing was completed and the designers got the green light in the fall of 1952. Although it was nip and tuck for a while, the designers finally pulled ahead and have completed their work, but the contractors are not far behind and are coming into the home stretch on a schedule which anticipates opening the project to traffic early this fall.

The project extends from the present Route U.S. 17, about 6 miles below Hardeeville, S.C., in a generally southerly direction across the Savannah River, and then through the western part of the City of Savannah, with connections to the central part of the city and to Route U.S. 17 south of Savannah (Fig. 1). The main channel crossing of the Savannah River is a 710-ft cantilever truss span which provides a 135-ft vertical clearance above mean high water. The main bridge structure (Fig. 2), made up of three central cantilever truss spans and fifty steel girder and beam spans on the approaches, is 6,034 ft long. Also in the project are the 3,200-ft concrete trestle across the Back River, and the interchange, constructed on earth embankment, on Hutchinson Island. The 6½ miles of approach roads in South Carolina include 3 miles of hydraulic embankment across the marshlands adjoining the Back River, and an overpass structure at the main line of the Seaboard Air Line Railroad. The Savannah approach contains the toll plaza and the entrance and exit roadways connecting the project to the center of the city.

A bypass connection for through traffic to Route U.S. 17 southbound is being constructed concurrently with the project by the city, county, and state, but is not legally or financially a part of the project.

All structures on the project have two-lane, 28-ft roadways and two safety curbs 2 ft wide. Bridge decks are reinforced concrete, except on the main channel span, where open steel grating is used. All highway construction has a 24-ft flexible pavement, with 10-ft stabilized shoulders. The project was designed according to the Georgia Standard Specifications for Roads and Bridges and the American Association of State Highway Officials Standard Specifications for Highway Bridges, using an H20-S16 live loading.

The crossing is being built by the Coastal Highway District of Georgia, which was organized by the State in 1924 from representatives of the six coastal counties of Georgia in order to construct the Coast Highway, Route U.S. 17. When the original route was constructed, it took a large loop to the west to avoid the difficult terrain covered by the present crossing, and crossed the Savannah River and its tributary channels 8 miles above Savannah at Port Wentworth. Since this location was above deep-water navigation, a low-level causeway of embankments and small structures was practical for the crossing at that time.

The growth of Savannah, particularly the expansion of industrial and port facilities along the south bank of the river between the city and Port Wentworth, and the increase in traffic on Route U. S. 17, have created considerable congestion and made this area one of the major bottlenecks on the Coast Highway. The new crossing will save through traffic 5½ miles and approximately a half hour's time, and bypass 76 street intersections, 5 railroad grade crossings, and 9 traffic lights on the present route. Another feature of the project is that it will provide highway access to hitherto inaccessible Hutchinson Island and permit the development of industrial sites on the island, along the north bank of the Savannah River, close to deep-water transportation.

The embankments on Hutchinson Island and in South Carolina rest on

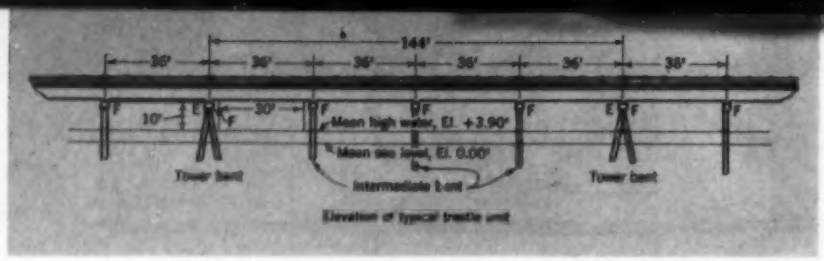


FIG. 3. Concrete trestle for Savannah River crossing is in four-span units, with every fourth bent a "tower bent" taking all longitudinal forces in the four spans.

deep layers of very soft and highly compressible clay, silt, peat, and muck up to 40 ft thick, which are underlain by a firm sand stratum. During the preliminary survey work, some sections of the marsh were found to be so soft that a man might suddenly sink up to his armpits without warning. This, plus the inhospitableness of the resident alligators and water moccasins, made it necessary for all survey personnel to work in pairs.

Various methods for constructing the three-mile embankment across the marshlands were considered, including sand drains, blasting, and complete removal of the soft material by dredging. It was finally decided, on the basis of relative costs, available equipment, and the limited time available, to place the embankment directly on top of the existing material, and to consolidate the marsh by the weight of the embankment plus a surcharge of additional fill temporarily placed on top of the embankment. The depth of surcharge was varied according to the depth of the marsh, in order to produce more uniform residual settlements after the removal of the surcharge.

The hydraulic dredge worked its way into the middle of the swamp and excavated a borrow pit by stripping the marsh material off the top of the sand stratum. The sand is then pumped through a pipeline and deposited along the line of the roadway. The embankment is being constructed in two layers. The first layer is spilled directly on top of the existing marsh. The second layer is deposited between dikes formed by bulldozers out of the material of the first layer.

Poured-in-place concrete trestle

The Back River trestle is of standard poured-in-place concrete construction. Precast and prestressed concrete were considered, but these alternative designs were not developed, principally because of the limited time available. The substructure consists of precast concrete piles 18 in. square, from 45 to 65 ft long, tied together with poured-in-place concrete caps. The 36-ft trestle spans are of monolithic beam and slab construction, with an overall depth of 4 ft 2 in. There are four beams, spaced 9 ft 6 in. on centers with a slab $7^1/_2$ in. thick.

The spans are arranged in four-span units, each unit being supported on three 4-pile intermediate bents, with a 6-pile tower bent at the end between units. At the tower bent one span is doweled and the other rests on a sliding bronze plate, with an open joint between the two spans for temperature movement. The tower bent is designed to resist all longitudinal forces on the four-span unit, the long piles of the intermediate bents not being counted on to produce any longitudinal restraint in bending (Fig. 3).

Concrete piers support main bridge

The main bridge is supported on 52 reinforced concrete piers. The four truss-span piers are twin shafted, and the 48 approach-span piers are of the single-shafted, hammerhead type. The subsurface investigations revealed that the same soft material, or muck, encountered in the South Carolina marshland, extends over the full width of Hutchinson Island to a depth of 35 ft, and at a lesser depth back into Savannah along the south approach. Some of the boring samples contained pieces of wood which indicated buried timbers. Actually, on Hutchinson Island, cypress stumps 4 to 5 ft in diameter, rooted in their virgin state, were found during excavation as much as 25 to 30 ft below the existing ground surface.

Underneath this material a fairly compact sand stratum was found extending under the whole length of the bridge structure, averaging about 20 ft thick. Below the sand the material was a stiff green silt with pockets of sand and clay and occasional hard cemented lenses, extending down as far as could be explored. In this area no rock is to be found within several hundred feet of the surface.

It was concluded that the sand layer was sufficiently thick and extensive and at a shallow enough depth, to permit supporting all the approach-span piers on timber piles, and that the green-silt stratum below was dense and firm enough to suffer very little compression from the pier loads after they were spread by the sand layer. All timber piles were designed for a capacity of 20 tons per pile. On Hutchinson Island, where it was impractical to carry the excavation for the pier bases down to the sand, the pier bases are located in the middle of the soft material, from 10 to 15 ft below the ground surface, the taller piers being embedded deeper than the shorter piers. To provide resistance against horizontal wind forces on the pier, the two outer rows of piles are battered outward on a slope of 1 to 6 on all four sides.

The four main-truss piers are founded on steel H-piles designed for a capacity of 50 tons per pile, driven deep into the silt stratum, as far as El. −95 for Pier 1S. The twin shafts and connecting top strut were analyzed as a continuous frame under the action of vertical and wind loads. Longitudinally, the shafts act as simple cantilevers sharing the load equally. The shafts of the anchor piers rest directly on the base slab, but for the main piers a horizontal distribution block was used to spread the load from the shafts over the base and reduce the bending stresses in the base slab.

Pier 1N is founded on 264 steel H-piles, with the bottom of the tremie seal at El. −48. The top of the pier is at El. 133, giving a total height of 181 ft. The design loads for this pier, in kips, are given below:

Vertical loads

Superstructure:	Dead load	2,940
	Live load	940
Pier dead load	25,360 (gross)	
Buoyancy	−7,050	
Net pier dead load		18,310
Weight of backfill above base		3,280
Total		25,470

Horizontal loads

Transverse wind:	
Superstructure, 30 psf	409
Pier, 30 psf	111
Live load, 200 lb per lin ft	132
Total	652
Longitudinal wind:	
Superstructure, 30 psf	325
Pier, 30 psf	115
Total	440

Each of the twin shafts measures 12 ft × 13 ft at the top, and tapers to approximately 14 ft × 17 ft at the bottom. The connecting top strut is 9 ft wide and 15 ft deep. The distribution block (hidden below water) has a depth of 16 ft, a width equal to that of the shafts, and a length of 66 ft. It cantilevers transversely

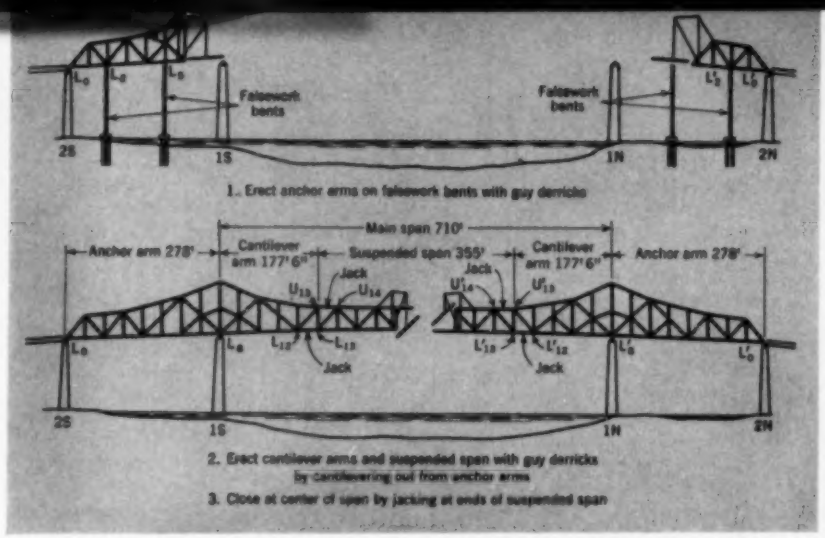


FIG. 4. Erection procedure for main span starts with anchor arms, which are assembled on falsework between Piers 1 and 2. When trusses have been landed on main piers, they are self-supporting, and channel span is erected by cantilevering to center of span. Jacks at ends of suspended span permit adjustment during closure operation.

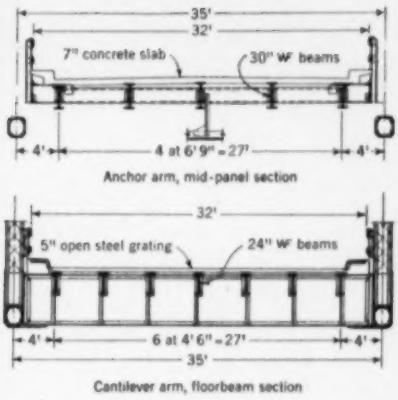
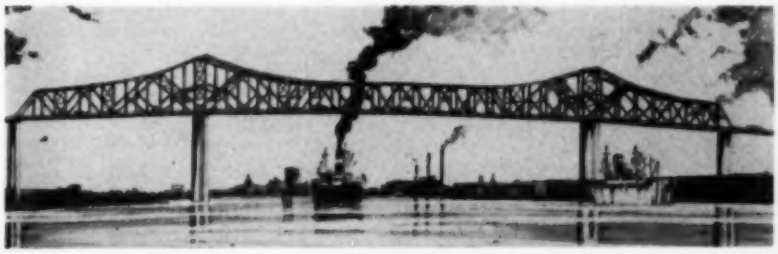
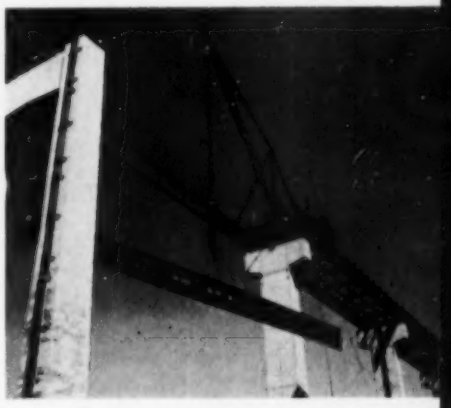


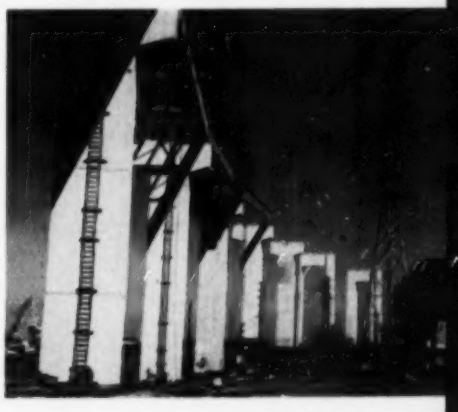
FIG. 5. Design of Savannah River crossing is shown by typical cross sections—through anchor arm at mid-panel and through cantilever arm at floor beam.



Main cantilever truss crossing Savannah River rests on four twin-shafted piers founded on steel H-piles. In architect's rendering, City of Savannah is in background.



In views above and below, steel is being erected over hammerhead piers of approach spans, adjacent to main bridge crossing, marked by twin-shafted piers. In photo above, crane places final 40-ton, 140-ft silicon steel girder in approach span. Single-shaft hammerhead piers, clearly shown in photo below, reach maximum height of 122 ft.



7 ft beyond each shaft in order to buttress the base slab and permit reducing its thickness. The base slab measures 44 ft 6 in. by 79 ft 6 in. and is 10 ft thick.

It is designed to carry all the upward load of the piles as an inverted slab, cantilevered out from the distribution block. The tremie slab, 16 ft thick, is not counted on for any structural strength, except what is necessary to distribute the concentrated load of the piles to a uniform upward pressure on the bottom of the base slab. In computing the required thickness of the tremie seal to balance the hydrostatic uplift when the cofferdam was unwatered, an uplift of 7 tons per pile was allowed on the steel piles, which were embedded in the tremie slab an average of 7 ft.

The single-shafted hammerhead piers for the approach piers have a constant transverse shaft width of 15 ft, and a top thickness varying from 7 ft to 3 ft, depending on the size of the pier. All the hammerheads are 31 ft wide. The tallest hammerhead pier, 3N, has an overall height of 122 ft and is supported on a base slab 37 ft × 43 ft, founded on 168 timber piles. Besides possessing a striking architectural appearance, these single-shafted piers are highly economical. The ratio of square feet of formwork to cubic yards of concrete for the shaft and hammerhead ranged from 9 to 12 for the girder-span piers and was about 18 for the 50-ft-span piers at the end of the bridge.

Design of the superstructure was influenced by the foundation conditions in that the nature of the materials indicated that pier settlements were to be anticipated. This dictated a fully articulated span layout so that any settlement would not introduce into the steel spans, stresses for which they were not designed. Simple spans were therefore adopted for all approaches, and a cantilever layout for the truss span.

The layout of the truss geometry started from the premise, based on earlier studies, that the economic length of the suspended span would be 40 to 50 percent of the main span. It was also desirable to use fairly

long panels in order to reduce the number of panels and the number of separate pieces to be handled. Therefore, two 5-panel cantilever arms and a 10-panel suspended span, with a panel length of 35 ft 6 in., were adopted.

There were several reasons why the anchor arm should be as short as possible. The first was economy. The steel for a through truss span might cost more than half again as much, per foot of bridge, as that for a deck girder span. There were no clearance requirements for the anchor arms, which are over dry land, and hence there would be no advantage in lengthening the span, as is sometimes the case, in order to avoid the cost of more piers in deep water. The second reason was the location of the railroad tracks on the Savannah side, which restricted the locations available for piers. The third was the horizontal curve on the south approach, which was necessary in order to bring the line down the canal right-of-way, and which had to be kept off the through truss for obvious reasons.

On the other hand it was desirable to limit the uplift on the anchor pier, and preferably to eliminate it, at least for dead load. The use of an open steel-grating deck and steel-plate curbs on the channel span permitted a considerably shorter anchor arm than would otherwise have been feasible. The length of the anchor arm is 278 ft, composed of 8 panels of 34-ft 9-in. length.

The reduced dead weight of the channel span is reflected in a substantial reduction in dead-load stresses throughout the trusses, and in a resulting large saving in the total weight of steel. For example, the stress in the top chords over the main pier is approximately 30 percent less than it would be if a concrete deck were used on the main span, for the same truss outline. See Fig. 5.

Over the main pier, the maximum depth of the truss is 90 ft, and at the end of the anchor arm and at the center of the suspended span the truss depth is 42 ft. The transverse distance between center lines of trusses is 35 ft, which provides nearly square panels for the X-bracing of the top and bottom lateral systems. Portal and sway bracing is laid out to provide an 18-ft vertical clearance above the roadway. Diagonal portal frames are provided at the end of the anchor arm, at the outer end of the cantilever arm, and at the end of the suspended span. A vertical frame and two diagonal portal frames radiate from panel point L_9 over the main pier to transfer the top-chord wind forces to the main pier.

The suspended span is hung from the ends of the cantilever arms at panel points 13 and 13′ by box-shaped hangers with pins at both ends, which permit rotation of the hangers and relative longitudinal movement of the spans. Pins in slotted holes are provided in the top chord at both ends of the suspended span, and in the bottom chord at the south end of the span, to permit the span to breathe under live load and temperature deformations, as well as to permit deformations from differential settlement of the piers, if they should occur, to take place without introducing stresses into the structure. The suspended span is tied to the north cantilever arm at the bottom chord by a pin which permits rotation but not relative movement.

At the end of the anchor arm, the back end of the truss is tied to the anchor pier through a pair of pin-connected linkage arms designed to take either tensile or compressive reactions and to permit longitudinal movement of the anchor-arm truss. These linkage arms are attached to structural-steel anchorages embedded in the top of the pier. The transverse wind load is carried to the anchor pier through a part of the embedded anchorage frame which rises above the pier along the center line of the bridge to engage a bearing attached to the bottom of the end floor-beam.

The truss is fixed to Piers 1N and 1S, and all longitudinal forces on the truss spans are transferred to these piers by a pair of fixed cast-steel shoes at each pier. Each shoe is bolted to the pier top with four anchor bolts of 3-in. diameter. The vertical reaction of 2,141 kips per shoe (dead load + live load + impact) is carried on a pin of 5-in. diameter.

Four different lengths of girder approach spans were adopted: 80 ft, 97 ft 7½ in., 120 ft and 140 ft. For appearance and duplication of fabrication, the girders for the two shorter span lengths were made 6½ ft deep, and those for the longer spans, 8 ft deep. The weight of a single 140-ft silicon-steel girder, the heaviest piece on the project, is 40 tons.

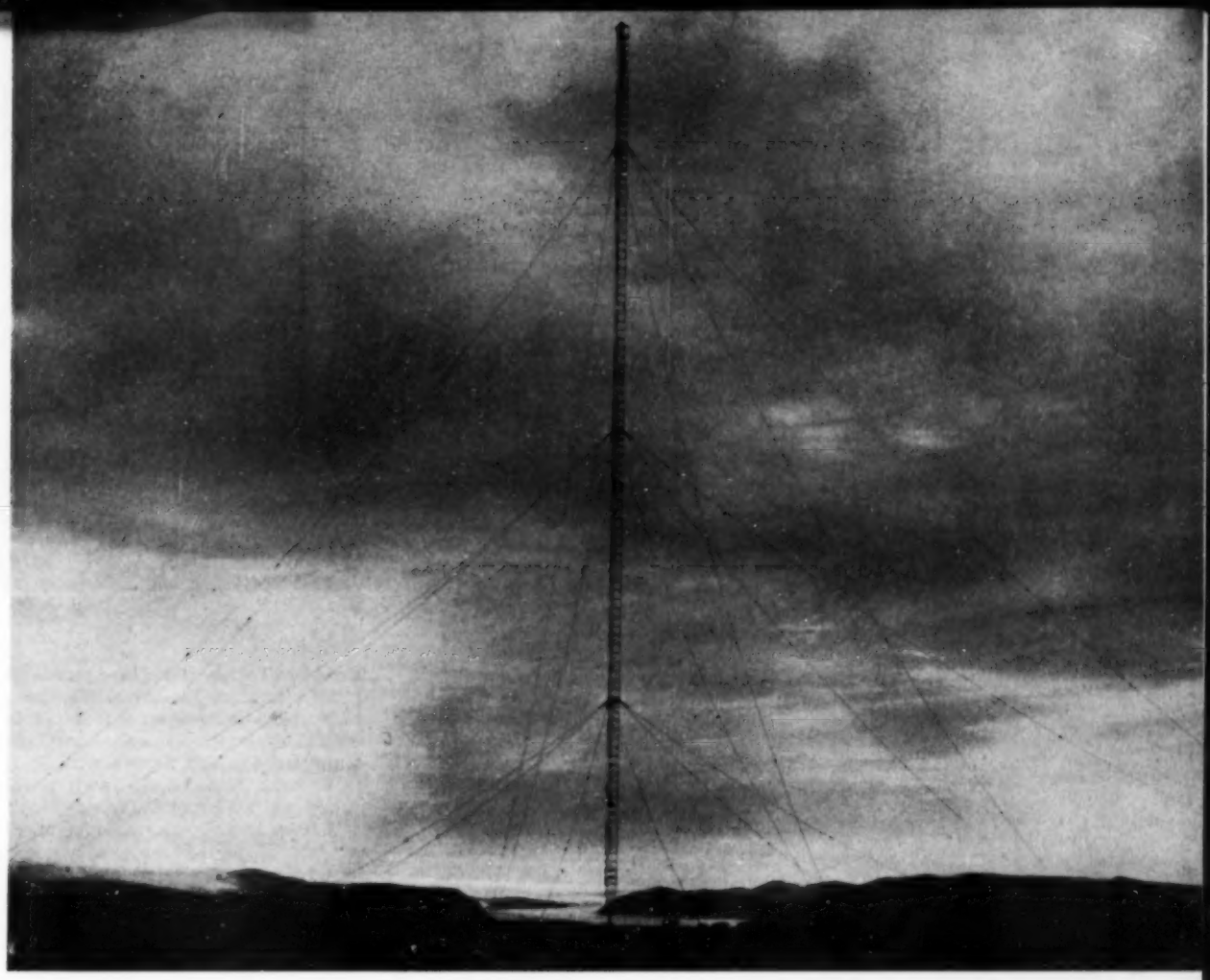
Primarily to reduce the number of toothed expansion joints required in the roadway deck, a system of double-fixed and double-expansion piers was selected, with each fixed pier taking the longitudinal forces from the two adjacent spans.

Erection of the approach girder and beam spans was accomplished by conventional means, with crawler cranes erecting from the ground and travelers riding on top of the stringers. On the Savannah approach, which is relatively easy of access, the crawler cranes erected 17 of the 24 spans, up to a height of approximately 80 ft above the ground, and then erected the traveler which completed the remaining spans. On the Hutchinson Island side, because the soft ground inhibits the use of heavy equipment, the crawler cranes erected only the first span. The traveler was assembled on top of this span as a platform, to erect the remaining 25 girder spans. The approach spans have a total length of approximately 4,800 ft and contain about 4,000 tons of steel.

The erection procedure for the truss spans consists of assembling the anchor arms on falsework between Piers 1 and 2 (Fig. 4). Two erection bents are provided under each anchor arm, at panel points L_2 and L_4. These steel bents are composed of standard box-shaped erection members which may be adjusted to any required length by telescoping. They rest on temporary steel-and-timber grillages supported on temporary timber piles. The truss spans are assembled by guy derricks.

After the anchor arms are landed on the main piers, the truss is self-supporting and the falsework bents are released. The main span is erected by cantilevering out from both ends to the center of the suspended span. A total of eight 300-ton hydraulic jacks are provided in the upper and lower chords at the ends of the suspended span. These jacks permit each half of the suspended span to be moved vertically, horizontally, and angularly during the closing operation. After the suspended span has been closed and pinned together at the center, the jacks are released until the span swings free.

Construction of the project began in November 1952, under a contract which calls for completion in two years. Progress to date is ahead of the required schedule for completion. The general contractor is Merritt, Chapman & Scott Corp. of New York. Principal subcontractors are the American Bridge Division of the U.S. Steel Corp., which is furnishing, fabricating, and erecting all the structural steel, and the Duval Engineering and Contracting Co. of Jacksonville, Fla., which is constructing the approach roads in Savannah and South Carolina, the Back River trestle, the Hutchinson Island Interchange, and the substructure for the northern end of the main bridge.



Arctic skyline is pierced by 1,212-ft radio tower at Thule Air Force Base. Guyed at three levels, tower has maximum width of 15 ft, and stands on cast-steel insulator dome.

World's third tallest structure erected in Greenland

Radio transmission tower rises 1,212 ft at Thule Air Force Base

S. D. STURGIS, JR.

Major General

U.S. Army

Chief of Engineers

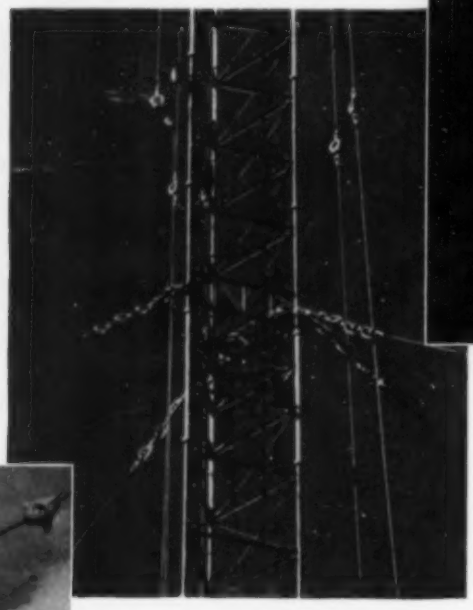
Washington, D.C.

The third tallest structure in the world now stands at one of the most remote corners of civilization, Thule Air Force Base in Greenland. Standing on two tiers of base insulators, the Thule radio transmission tower rises to a height of 1,212 ft 8 in. The two tiers of insulators are a temporary installation, to increase the gap between the tower and the ground. At a later date it is planned to replace them with possibly one large insulator, of the same or slightly greater height than that of the two tiers.

This tower, constructed under the supervision of the Corps of Engineers, U.S. Army, for the U.S. Air Force, is exceeded in height only by the Empire State Building in New York, N.Y. (1,472 ft), and a similar radio tower at Forestport, N.Y., which is 1,218 ft tall. Work on the Thule tower base and anchor blocks was begun in April 1952, and the actual job of tower erection was completed before the end of the short arctic summer.

In plan, the tower has the typical shape of an equilateral triangle, the vertices of which are the main structural members, or legs, spaced at 15 ft. The lower 50-ft length tapers to a bottom spacing of the members of 2 ft 3 in., and the members are bolt-connected through flanges to a steel casting, shaped to take and transmit

Tower is held by 18 guy wires (6 at each of three levels) under predetermined tension. Tower end of guy has four insulators, seen clearly in photo below. Intermediate insulators are also placed in guy line.



U-bolt and bridge socket at anchor end of guy cable (above) are used to take up tension. Large size of insulators may be seen from photo below.

the load from the tapered legs to a second steel casting, which decreases in diameter from 24 in. to 12 in. and bears, through a pin-and-socket arrangement, for possible thrust loads, on a dome-shaped casting, with a total compressive load of 1,140 tons. The bearing area on the domed casting is 89 sq in. See Figs. 1, 2, and 3.

The main tower members, or legs, up to the 321-ft level, which includes the lower guy connections, are rods of $8^1/_2$-in. diameter. From 321 ft to 706 ft, and including the intermediate guy connection, the rods are of $8^1/_4$-in. diameter. Between 706 ft and 922 ft, the members are 8-in. extra-heavy pipe inclosing rods of $5^1/_4$-in. diameter; from 922 ft to 1,042 ft, they are 8-in. extra-heavy pipe inclosing rods of $4^1/_2$-in. diameter; and from 1,042 ft to 1,066 ft, in the section containing the top guy connections, the rods are of $8^1/_4$-in. diameter. The tower extends 165 ft above the top guy connections. The first two panels above the top guy are made up of 8-in. extra-heavy pipe inclosing rods of $3^1/_2$-in. diameter, followed by one panel of 8-in., one panel of 5-in., and, at the top, two panels of 4-in. extra-heavy pipe. The interval between the bottom and top of a leg member is designated as a panel. The length of the panels are generally 24 ft, except at the tapered section, where they are approximately 12 ft long. All the main members are bolt connected through flanges with SAE 1,040 heat-treated bolts with a required yield point of 80,000 psi.

Bracing between the main members consists of paired angle struts and round diagonal tie-rods, which are provided with turnbuckles, with two bays of bracing per panel. At the guy connections, trusses 5 ft high are used instead of angle struts. The main members of these trusses are paired $6 \times 6 \times {}^1/_2$-in. angles.

Tower guyed at three levels

The guys take off at three levels: the low guys at 294 ft above the top of the base insulator, the intermediate guys at 654 ft, and the top guys at 1,038 ft. There are six lines of guys, three lines opposing three lines, with a low, intermediate and top guy on each line, making a total of 18 guy wires. The guy lines terminate at anchor blocks laid out on lines diverging at 60 deg from the tower legs, so that opposing guys are in the plane of one face of the tower, and each leg is guyed along the planes of its adjacent faces. Top and intermediate guys are $2^1/_4$-in., 7×19 stranding, galvanized, special wire rope, with a minimum strength of 186 tons. Each guy line is provided with a linkage assembly at the anchor end, and a U-bolt and bridge socket with 6 ft of takeup for tensioning. The tower end of a guy is made up of a group of four insulators. Individual insulators are spaced at irregular intervals in the line, the top guy having four and the intermediate and low guys, three each.

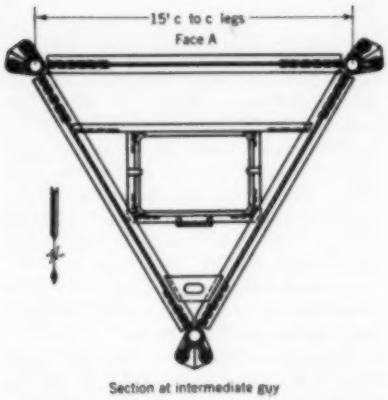


FIG. 1. Typical tower section is equilateral triangle 15 ft on a side. Lower 50-ft length of tower tapers to 2-ft 3-in. spacing of main members. Section here shown includes connections for intermediate guys. Interior framing is for elevator shaft.

FIG. 2. Tower bears on cast steel dome through pin and socket and double tier of insulators. Total compressive load is 1,140 tons. Bearing area on dome is 89 sq in.

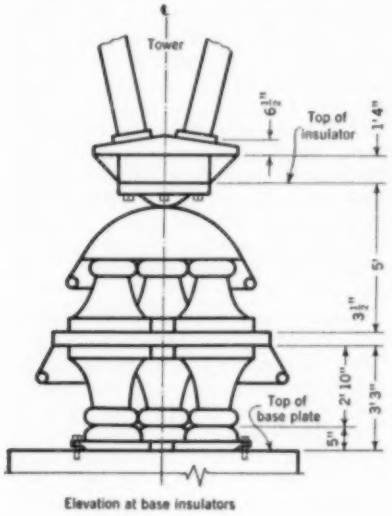
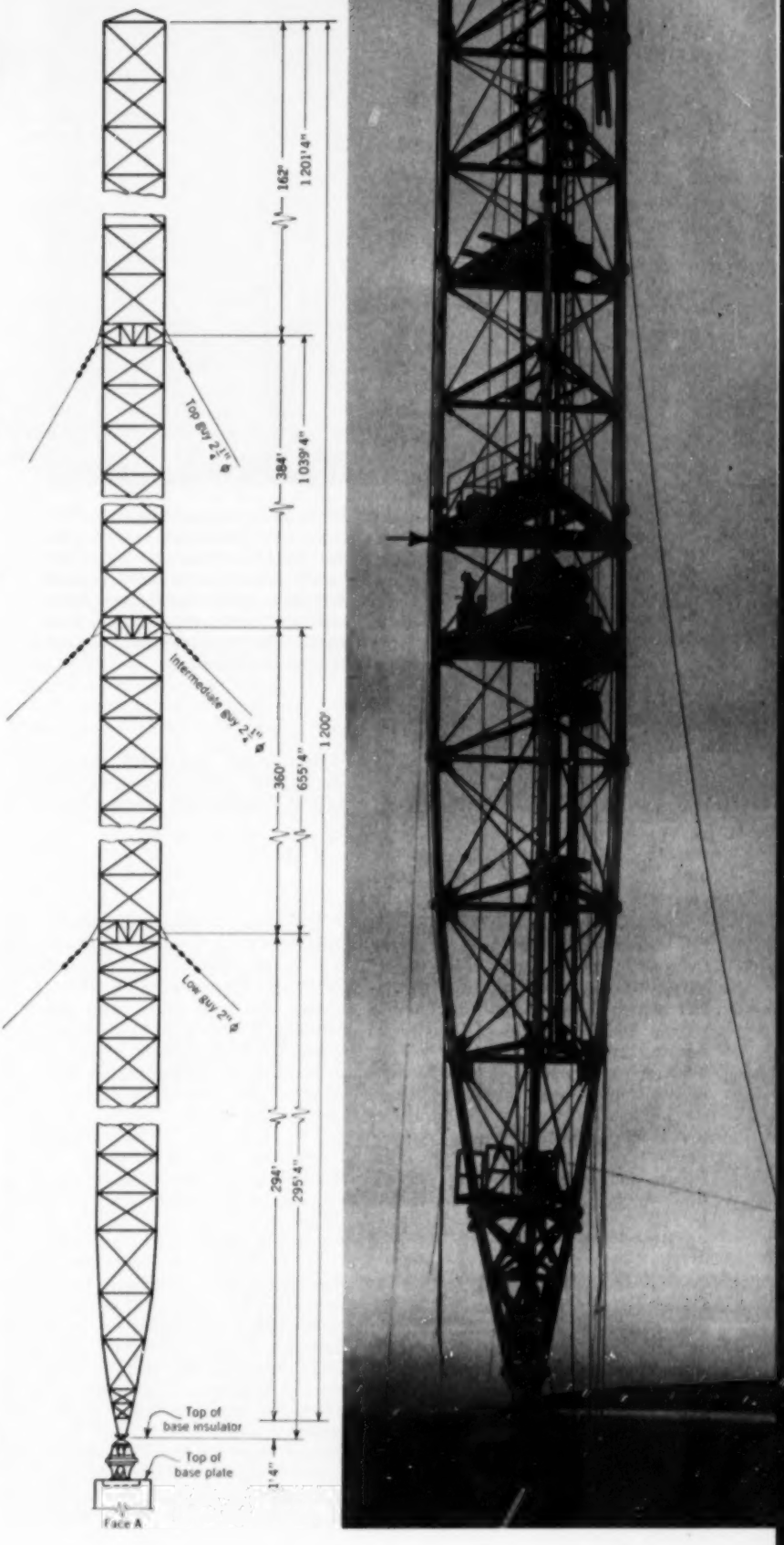
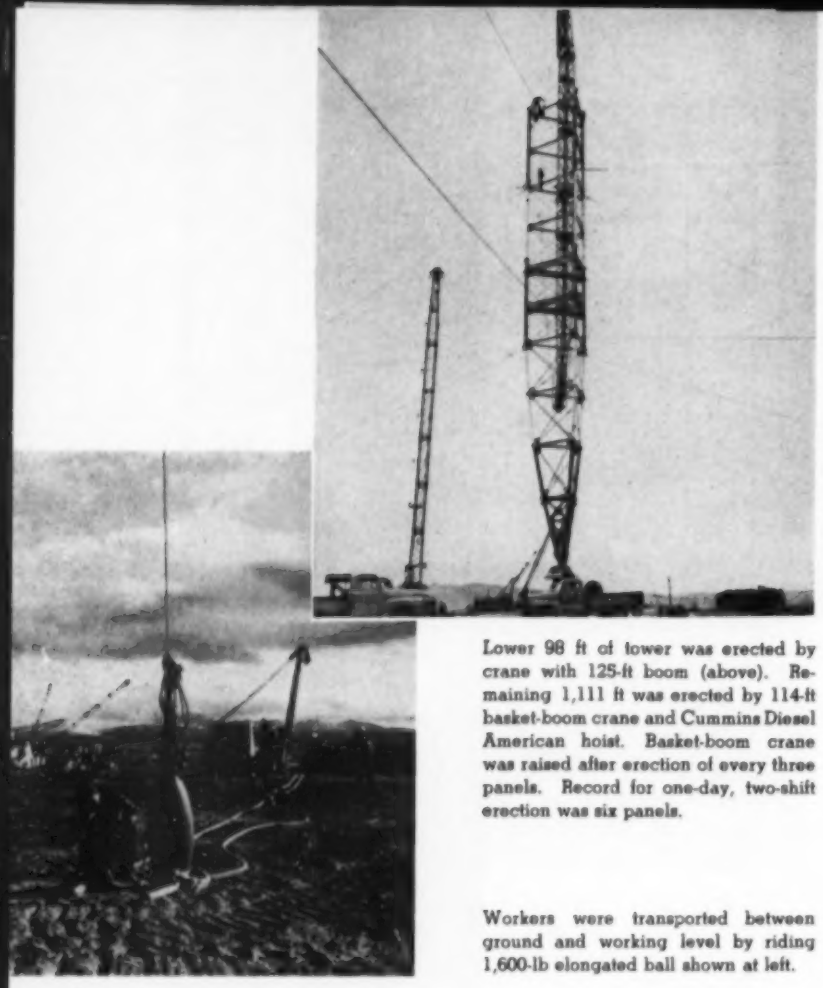


FIG. 3. (Right) Main members of tower consist of pipe ranging in size from 8½ to 8 in. in diameter, except for three top panels, which have 5-in. and 4-in. pipe. Bracing between main members consists of paired angle struts and wind tie-rods for diagonals. Panels are generally 24 ft long.

(Photo, far right) Access to bottom elevator landing (arrow), 76 ft 11 in. above ground, is by ladder. Machinery will be housed just below this landing inside Galbestos walls, with steel-plate roof and floor. Elevator, capable of carrying four men comfortably, rises 1,171 ft 11 in. above ground.





Lower 98 ft of tower was erected by crane with 125-ft boom (above). Remaining 1,111 ft was erected by 114-ft basket-boom crane and Cummins Diesel American hoist. Basket-boom crane was raised after erection of every three panels. Record for one-day, two-shift erection was six panels.

Workers were transported between ground and working level by riding 1,600-lb elongated ball shown at left.

The inner anchor blocks for the low guy wires are at distances varying from 539 ft to 548 ft from the center of the tower. Intermediate and top guy wires have common anchorages (outer anchor blocks) at distances varying from 1,055 ft to 1,077 ft. The horizontal distances vary because of the sloping terrain and the necessity of maintaining equal guy angles for each group of guys. Anchor blocks are of concrete, 16 ft 6 in. square, by 10 ft 0 in. deep for the inner anchors, and 22 ft 0 in. square, by 10 ft 0 in. deep for the outer anchors.

The tower base was designed for a bearing of $1^1/_2$ tons per sq ft, and the anchor blocks for 1 ton per sq ft. Guy connections to the anchor blocks are positioned so that no uplift occurs under the windward side of the block. Horizontal forces on the anchor blocks are counteracted by frictional resistance on the bottom of the blocks with a safety factor against sliding of $1^1/_3$. Additional safety is obtained from the passive earth pressure around the block.

The tower is provided with an elevator and ten landing platforms for use in inspection and maintenance. With the bottom landing 76 ft 11 in. above the base plate, and the top landing 1,171 ft 11 in. above this plate, the total straight lift is 1,095 ft. Intermediate landing platforms are at beacon and obstruction lights. The cab, of steel plate, 2 ft 8 in. × 3 ft 9 in. × 10 ft 0 in., is large enough to carry four men comfortably. A 15-hp two-speed, two-winding, squirrel-cage induction motor does the work. Hoist ropes are $4^3/_4$ in., 6 × 19 stranding, galvanized-steel cables.

A 14,000-lb counterweight below the machinery platform maintains tension in the cables. The machinery is housed inside Galbestos walls and steel-plate roof and floor. Access to the bottom landing platform is gained by means of a removable wood ladder from the concrete base to the permanent tower ladder, and by tower ladder up through the machinery room to its roof, which forms the bottom landing platform. The controls are mounted on the machinery platform, and telephone communication is provided between the operator and each platform. There is no direct communication between the operator and the cab. The cab can be stopped at any point in the tower, the operator being guided by a moving-arm indicator. For emergency use, a steel ladder has been installed, with rest platforms at 48-ft intervals.

Beacon lights are mounted at 240-ft intervals, with obstruction lights midway between the beacons.

The tower has been designed for a horizontal wind force of 74 psf on flat surfaces and 58 psf on cylindrical surfaces. Under this load it will sway approximately 9 ft off plumb at the top.

An electrical counterpoise, or lower condenser, of radial ground wires is laid out from the tower at a 3-deg divergence angle, and covers an area of 1,200-ft radius.

Tower base and anchor blocks were constructed by the general contractor, North Atlantic Constructors, during the months of April and May 1952. The most unusual problem in connection with the building of the tower was the design of the foundations to overcome the permafrost conditions prevailing in that arctic land. There are two assumptions between which an engineer must choose before starting a foundation design in the arctic. He must decide either to maintain the thermal balance or to permit the permafrost table to recede. In planning the foundations for the tower at Thule, the former assumption was adopted.

Several pits were dug at various points near the site, and the soil conditions encountered were found to be relatively uniform over the entire area. The soil generally consists of very silty sand of low density, with from 30 to 50 percent ice in the form of ice lenses. When thawed, this material has insufficient bearing value for a structure of this type. It was therefore essential to maintain the soil in a completely frozen state. To do this, the foundation was excavated during the winter to a depth 6 ft below the proposed bottom elevation of the concrete blocks. The pit was then backfilled with non-frost-susceptible sand and gravel and allowed to come to the temperature of the surrounding soil. The concrete blocks were built on this insulating blanket. Grades for the blocks were set so that $1^1/_2$ to 2 ft projected above the original ground. All the blocks settled from 5 to 8 in. The major part of this settlement took place in the first week after pouring, but settlement continued at a diminishing rate for six

weeks. Air temperatures during this period fluctuated above and below the freezing point, permitting the ground to thaw sufficiently to cause melted water to flow from the sides of the pit into the backfill material. Added to this was the heat of the concrete mass, placed at a minimum temperature of 55 deg F, and the continuing heat of hydration of the cement during the setting-up and aging period. These factors all contributed to cause melting of the frozen material and resulted in compaction under the weight of the block. It was in consideration of these factors and the anticipated settlement that the foundation was constructed under winter conditions. Construction during the winter season minimized the effect of this operation on the underlying permafrost and insured that the foundation would arrive at a condition of equilibrium before the start of steel erection.

Tower erection subcontracted

Erection of the tower was subcontracted to the John F. Beasley Construction Co., of Muskogee, Okla. The working force arrived at the job site on June 28, 1952, and the men were on the job at the start of shift No. 1 the following day. An erection superintendent, A. B. Carroway, 2 foremen, 2 hoist operators, and 18 iron workers constituted the Beasley force, and 4 tractor operators were furnished by the contractor, North Atlantic Constructors. For the first 98 ft of the tower, the contractor also furnished two crane operators. The above combined force was divided into two shifts of 10 hours each until July 17, 1952, when the shifts were extended to 11 hours each. Because of the latitude, the sun never sets during this season of the year, so both shifts were working in daylight. The contractor also supplied the crane and two side-boom tractors.

On July 8, 1952, the 48-sq ft, steel hexagonal base plate, 4 in. thick, was put in place. It weighed about 10,000 lb. For grouting, it was suspended from two 8-in. I-beams, supported at the ends by hydraulic jacks, over a boxed-out depression in the concrete base. The suspenders were bolts passing through holes in the bottom flanges and threaded into tapped holes in the plate. This arrangement simplified vertical adjustment and leveling without the use of shims. Grouting was done with 2¼ cu yd of ¾-in. stone concrete by the contractor's forces.

On July 11, the essential parts of the contractor's erection equipment arrived by plane, and erection of the tower began on July 12. At the end of the second shift on July 13, the tower was erected to the top of panel F, 98 ft above the base plate. A crane with a 125-ft boom was used for erection up to this point. The hoist and part of the basket-boom required for further erection had been delayed in transit and did not arrive at the job site until July 15. The hoist was set up and the basket-boom, 114 ft long, erected inside the tower ready for use by the second shift of July 17. Erection continued without further interruptions, except for approximately 30 hours lost on account of high winds, until August 3, at which time the top panel was erected and a temporary light mounted on top for an aircraft warning.

The record for daily two-shift erection was established on the last day, with the erection of all six panels above the top guy-connection panel. A ground fog on this day completely cut off the signal man on the ground from the sight of the men working topside in the clear, and effectively demonstrated the reliability of the telephone communication system between the signal man and the erection crew.

For transportation between the ground and their working position on the tower, the men "rode the ball," a 1,600-lb elongated-type weight on the end of the load line. The hoist was a Cummins Diesel American hoist with a torque converter, a line pull of 14,000 lb, one load line, and one line for jumping the boom.

Stringing up and tensioning erection guys took about six hours. Permanent guys took two complete shifts. The basket boom was raised after the erection of every three panels.

The tower was plumbed on August 4 in three shifts, while transit stations were being established for tensioning the guys. The correct tension in the guys was obtained by placing a mark on the guy wire which would be in the same horizontal plane with a similar mark on the tower leg when the cable was pulled into the correct catenary curve. This curve would be formed only under the required tension. To determine when the mark on the guy wire was in a horizontal plane with the mark on the tower leg, a transit station was established, equidistant from the mark on the lower leg and the mark on the guy, when the guy was in the proper catenary. The telescope was clamped with the intersection of the cross-hairs on the tower-leg mark and the transit then turned on its vertical axis to the guy wire. The mark on the guy was then moved by tensioning the guy until the mark was at the intersection of the cross-hairs. The guy wire was then in the proper catenary curve.

For this method of tensioning, the erection drawings supplied the survey data for laying out the transit station, as well as the measured distances to the marks on the guy wire and the tower leg, with tables for temperature corrections. It was necessary to tension only three lines of guys at each level with the above method since, with the tower held plumb, the opposing guys would have the same tension. Take-up on an opposing guy was made simultaneously with the take-up on the guy whose tension was determined as described above. The operation of tensioning, including the replacing of a 4-ft link with one 2 ft long, required five shifts and was completed August 7.

The forces of North Atlantic Constructors laid the electrical counterpoise of No. 6 copper wires, using a rooter on which was mounted a reel of wire. The wire, fastened at one end, was unwound and laid in the narrow 12-in.-deep trench as the rooter moved along the line. The radial wires were laid by the rooter in 80 hours. An additional 95 hours were required for grounding anchor blocks and soldering connections to a bus around the tower base.

In appearance the tower is well proportioned. It does not seem to be of great height, possibly because of the massive landscape background, even though it is the third tallest structure in the world.

The tower was designed and fabricated for the Air Force by the Truscon Steel Co. The Otis Elevator Co. designed the elevator, and the Lapp Insulator Co. designed and supplied the porcelain insulators and domed castings. The contractor, North Atlantic Constructors, is a joint venture of the contracting firms of Peter Kiewit Sons Co., S. J. Groves & Sons Co., Al Johnson Construction Co., and Condon Cunningham Co. Inc., organized for the construction of the Greenland bases, under the direction of the Northeast District, Corps of Engineers, Col. Morton Solomon, District Engineer. Materials were furnished by the Corps of Engineers. The John F. Beasley Construction Co., which had erected the 1,218-ft tower at Forestport, N.Y., proved on the Thule job that its outstanding reputation for tower erection is based on outstanding accomplishment. Resident engineer on erection was Sven B. Svendsen, of Severud, Elstad & Kreuger, structural engineers for Metcalf & Eddy, and Alfred Hopkins & Associates, architect-engineers.

Double 90-in. pipeline of precast concrete pipe carries storm runoff through park area where contractor had to work in right-of-way only 50 ft wide to preserve grove of fine trees. Stiff-leg straddling ditch placed as much as 320 ft in one day. Total length of this double line was 2,709 ft. Total length of 90-in. pipe used, including single lines, was 10,071 ft. On entire project only one joint was lost by breakage.

Twin 90-in. concrete pipelines divert storm runoff for Paducah, Ky.

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Principal Assistant Engineer

Black & Veatch, Consulting Engineers

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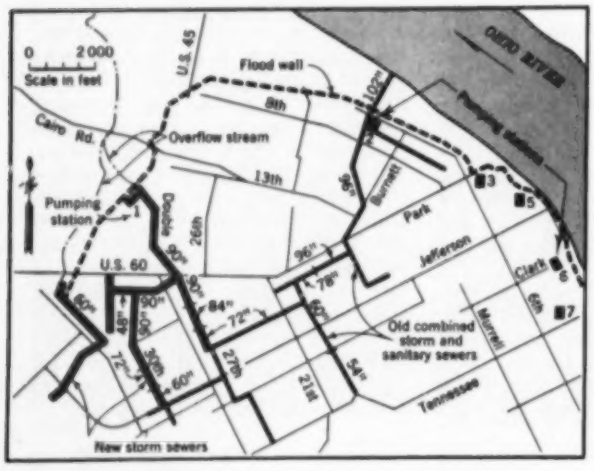


FIG. 1. Wide black line shows location of new storm sewers for Paducah, Ky., included in project here described. All pipelines are single except that marked "double 90-in."

Because of limited finances at the time of original construction, Paducah's old system of combined sewers was not constructed of sufficient size to collect the storm water from the entire tributary area. Subsequent development south of U.S. Highway 60 and west of 21st Street resulted in overloading the old system of combined sewers and caused extensive flooding in the business district.

The system of new storm sewers which is here described and shown on the map, Fig. 1, not only corrects this situation but also provides service to areas of the city previously unsewered.

Paducah is located at the confluence of the Ohio and Tennessee Rivers and most of the area within the city limits is below the flood level. The city is protected from inundation by a concrete flood wall and earth levees, and seven pumping stations discharge storm water and sanitary sewage during periods of high river stage. The flood wall and pumping stations were constructed by the Corps of Engineers following the 1937 flood.

Storm runoff as well as sanitary sewage is collected in a combined system which discharges into the Ohio River adjacent to Pumping Station No. 2. The principal trunk sewers in this system vary from 30 to 102 in. in diameter. That part of the city immediately adjacent to the Ohio River and tributary to Pumping Stations Nos. 3, 5, 6, and 7, is served by relatively small separate systems of sanitary and storm sewers.

Improvements planned in advance

In 1947 Paducah obtained funds from the Federal Works Agency for the advance planning of improvements to eliminate existing deficiencies and to provide storm sewers for areas that were under development in the western part of the city. The long-range planning of the city contemplates the construction, at some future date, of a sewage treatment plant adjacent to the old 102-in. combined sewer in the vicinity of Pumping Station No. 2. (See map, Fig. 1). Therefore it was necessary to develop a plan of storm-sewer improvements that would provide the necessary relief to the existing combined system and also allow the normal flow of sanitary sewage to be carried to the treatment plant site through the existing combined system and through a separate sanitary system serving the southwestern part of the city.

That part of the city which is west of 30th Street is above the level of maximum river stage. Therefore, the 60-in. storm sewer in this area will intercept storm-water runoff and convey it to the river side of the flood levee without pumping.

Relief for the overloaded combined system is provided at 27th Street and at 30th Street. At each of these locations side-channel overflow structures permit the diversion of storm-water runoff to the new storm sewers. The normal flow of sanitary sewage at these locations will be carried by the old combined system. The lower part of this system of new storm sewers consists of twin 90-in. pipes which terminate adjacent to the forebay of Pumping Station No. 1. During periods of normal river stage, the storm water discharged through the twin 90-in. pipes will flow by gravity to the river side of the flood protection levee through three 60-in. pipes provided with flap gates. During periods of high river stage, the storm water will be diverted into the forebay of Pumping Station No. 1 and subsequently pumped to the river.

Design for two-year storm

Rainfall records for a 42-year period at Cairo, Ill., were used to prepare skew curves for the 5-min, 10-min, 15-min, 60-min, and 2-hour intensities. These curves were subsequently used to prepare intensity curves for the probable 2-, 5-, and 10-year storms.

After a study of the maximum observed precipitation in Paducah and after consideration of the duration of floods of various stages, the 2-year storm was selected as the basis for design of improvements. This storm was estimated to have an intensity of 1.43 in.-hours for a 60-min period. Storms in excess of the probable 2-year storm will cause surcharge on some of the sewers but are not likely to result in serious ponding.

A field survey of five typical residential areas determined that approximately 35 percent of the total area was impervious and 65 percent was pervious. Therefore these factors were used to determine the ultimate runoff from the entire tributary area with the exception of parks, which were considered to be 100 percent pervious.

The 60-in. storm sewer, which discharges on the river side of the flood levee near U.S. 60 provides a capacity of 160 cfs which represents the calculated runoff from a 2-year storm after the ultimate development of the tributary area. The twin 90-in. pipes, which run further west between U.S. Highway 60 and Pumping Station No. 1, provide a capacity of 475 cfs.

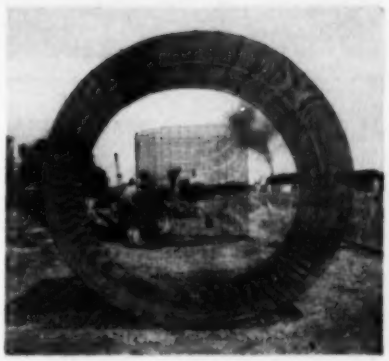
The use of the double 90-in. pipes or a double box conduit was required by the relationship between the limiting invert elevation of the drainage pipes through the flood wall and the maximum available hydraulic gradient at U.S. Highway 60. The contractor elected to use the twin 90-in. pipeline rather than a double box conduit. The pipeline runs through a municipal park, and the cut from natural ground to invert varies from 18 to 20 ft. Also, the pipeline crosses major highway arteries. Therefore the twin pipe construction was selected in lieu of a paved open channel.

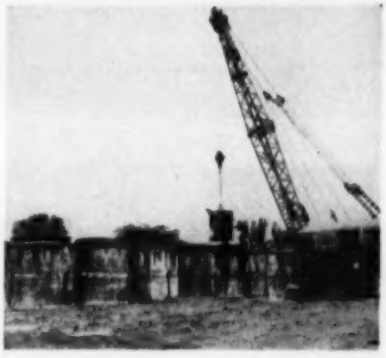
Construction work well planned

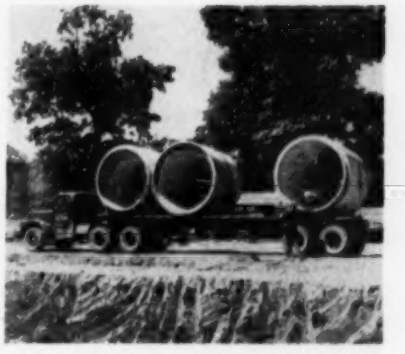
In 1952 Paducah received a grant from the Federal Housing and Home Finance Agency for the construction of the storm sewer improvements. Bids were received on November 18, 1952, and the contract was awarded to the D. W. Falls Construction Co. of Tulsa, Okla., which submitted the low bid of $1,023,527, about $120,000 below the engineer's estimate. The principal items of work included approximately 16,000 ft of reinforced concrete pipe varying in diameter from 60 to 90 in.

To eliminate the uncertainty and risk involved in the relocation of existing water and gas mains, the contract contained a lump-sum payment for each of these items, which was used by all contractors as the basis of their bids. The various utilities were subsequently relocated as required by the water company or the gas company. The cost of these relocations was paid to the proper utility company by the contractor. At the conclusion of the job, the lump-sum items were adjusted to reimburse the contractor for his actual cost.

Weather conditions during the construction period were excellent. It was necessary to use well points only on the lower part of the double 90-in. outfall, and practically no trench sheeting was found necessary. The question may be asked as to what type of soil it was that stood on vertical slopes without sheeting or shoring. The soil encountered was a heavy silt with sand lenses; it was highly plastic and had a static water level beneath the grade line. This soil would not have stood vertically for a long period, and only the speed of the construction sequence made it possible to eliminate sheeting and shoring.



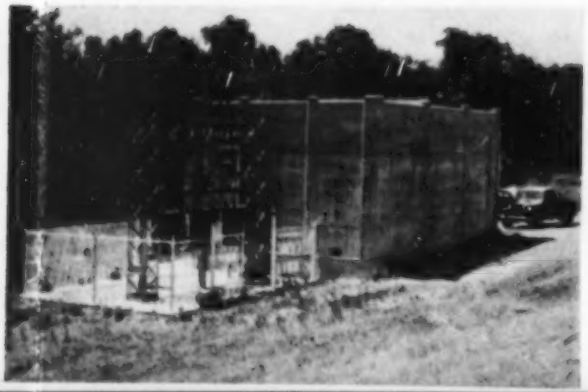




All precast concrete pipe for project was made by Universal Concrete Pipe Co. at its yards in Metropolis and Brookport, Ill., respectively about 15 and 3 miles from site. Upper photo shows steel reinforcement assembly for 90-in. pipe, with 40-diameter lap at top. With steel spacers, cages were accurately anchored in molds, seen in middle photo at Brookport yard. Lower photo shows pipe arriving at site by trailer truck.

The sequence of construction operations was generally as follows: (1) Clearing right-of-way; (2) trenching with a 2-cu yd backhoe; (3) placing the pipe with a stiff-leg

Backhoe digs trench for 90-in. twin line while dozer piles spoil (top view). Pipe, unloaded by Bucyrus 22-B crane (next below), was lined up at trench side. Pipe was placed by stiff-leg resting on structural steel framework spanning 40 ft between monorails on each side of ditch (third photo). Trench is 27 ft wide and 19 ft deep at this point, where radius pipe is laid around 28-deg bend. Placing is quickly followed by grouting of lifting holes and joints(fourth photo). Sequence was finished by backfilling with river sand to 1 ft above crown, inundating, and final backfilling with earth. Speed of work as well as low water table and nature of material made it possible to omit sheeting.



Lower part of new storm sewer system, consisting of twin 90-in. pipes, terminates at Pumping Station No. 1, here shown under construction. At normal river stages, flow passes through levee by gravity.

derrick, for the double line of pipe, or for a single line, with a Bucyrus-Erie 38-B crane; (4) joint sealing with portland cement gunite; (5) backfilling with river sand placed with a bulldozer and inundated to a point about 1 ft above the crown of the pipe; and (6) complete backfilling with earth by bulldozers, sheepsfoot rollers and motor grader.

The contractor's operations were well planned, and the equipment provided for the job was well suited to the working conditions. The excavation for the double 90-in. pipes was performed by a backhoe having a rated capacity of 2.0 cu yd. A small bulldozer provided with a template blade was used to shape the subgrade. The concrete pipe was manufactured in Metropolis and Brookport, Ill., and transported to the ditch bank by truck.

Since the double 90-in. pipes run through a grove of very beautiful trees in the municipal park, the right-of-way was limited to a width of 50 ft. It would have been impossible in this width to provide space for a ditch and spoil bank leaving room to work a heavy crawler crane. A crane of sufficient capacity to handle pipe of the size required would have needed an additional 50 ft of right-of-way. Therefore, to minimize the difficulties of the confined working space, the contractor designed a traveling stiff-leg derrick to place the pipe. This derrick utilized the dead space above the ditch, which averaged 27 ft wide at the ground line. This derrick was pushed or pulled along by a bulldozer, and was supported on a structural steel framework which spanned 40 ft between monorails laid along the edges of the ditch. The main beam under the stiff-leg mast consisted of two 33-in. H-beams, each weighing 140 lb per lin ft. These beams were rolled to a 4-in. camber to take care of load deflection.

Pumping station enlarged

Modifications to flood levee Pumping Station No. 1 are included in the project and are under construction. This station, as originally designed and constructed by the Corps of Engineers, had two electric pump units of 17,500 gpm each. The modified station will have three pumps each of 22,000-gpm capacity. A new 60-in. gravity pipe and a new 30-in. steel force main will be built through the levee. This construction is being performed by Chism & Miller of Paducah.

In designing the improvements, the approval of both federal agencies involved, the Corps of Engineers and the Housing and Home Finance Agency, had to be secured. Strange as it may seem, no serious labor difficulties were encountered.

The design and plans were prepared and construction supervised by Black and Veatch, consulting engineers of Kansas City, Mo., with I. G. Parsons, A.M. ASCE, as resident engineer. Tom A. Bradley, City Engineer of Padaucah, was sponsor for the city.

All pipe for the project was supplied by the Universal Concrete Pipe Co. and installed by the D. W. Falls Construction Co. of Tulsa, Okla., under the supervision of W. H. Gilliard, A. M. ASCE.

Roof of vermiculite concrete poured on insulation board

A new type of roof system that is economical, has good insulating value, and is not damaged by exposure to weather before built-up roofing can be applied, has had its first major application on the 170,000-sq ft plant of the Strietmann Biscuit Company now nearing completion in Macon, Ga.

The system consists of a slab of vermiculite insulating concrete 2 in. thick poured in place on a permanent form of 1-in. rigid insulation board, the under side of which is exposed to provide the ceiling of the factory. The board lies on the lower flanges of bulb tees that are welded to steel joists. The concrete is reinforced with galvanized welded wire mesh laid with the long dimension at right angles to the tees.

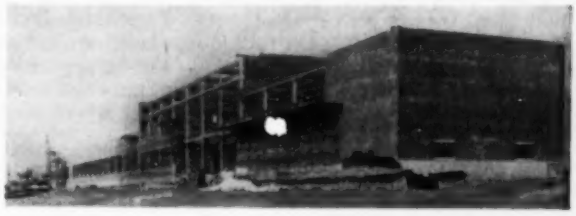
This deck weighs only 7.7 psf, and has a "U" value of 0.15. With its continuous reinforcing and welded subpurlins, the roof is an integral part of the main steel construction and adds rigidity to the entire building.

After the concrete had cured for a week under favorable weather conditions, it was covered with a 5-ply 20-year bonded built-up roof.

The factory is a rectangle with a north-south axis, of one story except for the two-story section at each end. The main steel trusses are uniformly spaced north and south 20 ft on centers and are supported by steel columns. Spacing of the steel joists from east to west varies considerably because of requirements within the building.

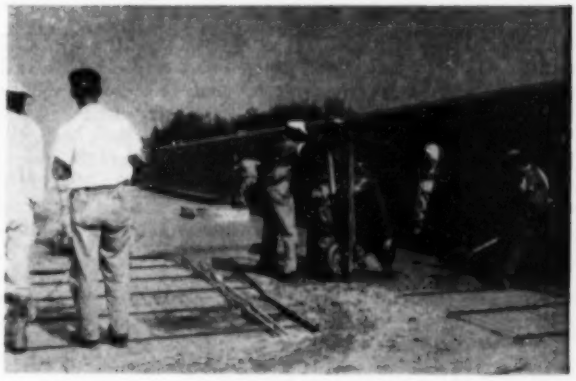
The bulb tees supporting the form board are spaced $32^{5}/_{8}$ in. on centers. The span varies from 7 to 8 ft because of the joist spacing. The tees weigh about 3 lb per lin ft and have $^{5}/_{8}$-in. flanges. Each tee was welded to the joist on alternate sides of the tee.

The form board, 32 in. wide, was precut by the manufacturer in lengths to fit the joist spacings so that where two ends of board meet, they do so over a joist, and not between spans. For sanitary reasons the surface that makes the ceiling of the factory was finished with a calendered mineral

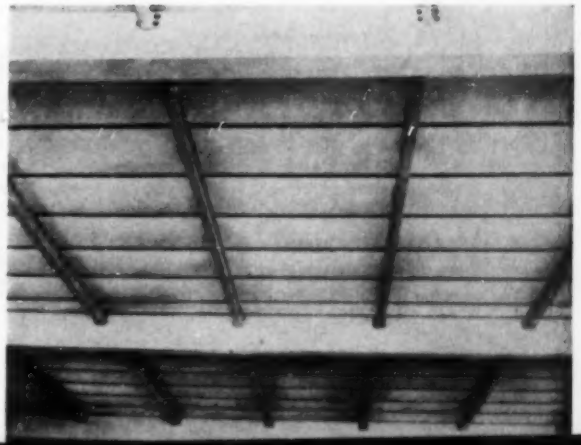


Factory of Strietmann Biscuit Co. in Macon, Ga., marks first major use of new type roof. At far left in distance can be seen tower and bucket carrying vermiculite concrete to roof hopper.

Bulb tees are being welded to steel joists to carry insulation board, which will act as form for vermiculite insulating concrete, as well as ceiling for factory space below. Welder standing upright is straddling wood expansion joint running crosswise of building.



From roof hopper, concrete is buggied to pouring site, dumped over welded wire mesh and form board, and roughly leveled. Longitudinal wires are 12 gage, cross wires, 14 gage. Screeds of 1-in. iron pipe laid across tops of bulb tees assure uniform 2-in. thickness. Shovelfuls of concrete kept pipes from rolling.



Permanent form of 1-in. rigid insulation board constitutes ceiling, here seen under poured section. No excessive deflection is evident. Black lines are bottom flanges of bulb tees.

pigment coating, ivory in color and very smooth. The board has a bevel $1^1/_2$ in. wide on the long edges of the coated surface to make it fit flush on the tee flanges and leave no open space in which dust or vermin can collect. Neither the coating nor the beveling would be necessary on a normal job. As soon as an area of board had been laid, it was covered with 4 × 8-in. galvanized welded wire reinforcing mesh.

The vermiculite concrete is a 4:1 mix (1 part portland cement to 4 parts vermiculite aggregate). On this job a mobile mixing unit was used, consisting of a batching box, a rotating drum, and a bucket traveling vertically in a tower and discharging into a hopper on the roof. Water was piped automatically into the drum, the amount controlled by a meter on the machine. The deck was placed in strips about 12 ft wide. On the average, 15,000 sq ft of concrete was placed daily with a crew of 17 men, including the foremen. Setting time varied between 2 and 6 hours. It was usually possible the following morning for workmen to walk carefully on the previous day's pour. Cant strips of the concrete were placed around the outside walls and the numerous vent openings.

Experience on this and other buildings, where roof decks of this type have been installed, indicates a cost ranging from 45 to 60 cents per sq ft, depending on the area involved and other conditions. Gypsum or cement asbestos board may be used as alternates for the permanent form, and the deck can be designed for any required loading.

Designed and erected by the Rust Engineering Company of Pittsburgh, Pa., and Birmingham, Ala., this factory has a roof area of 145,000 sq ft. The deck was installed by the Vermiculite Placing Co. of Atlanta, Ga., under the direction of R. W. Sterrett. J. W. Braswell, of the Rust Engineering Company, was in charge of the entire project.

ENGINEERS' NOTEBOOK

Preliminary sections determined for concrete gravity dams

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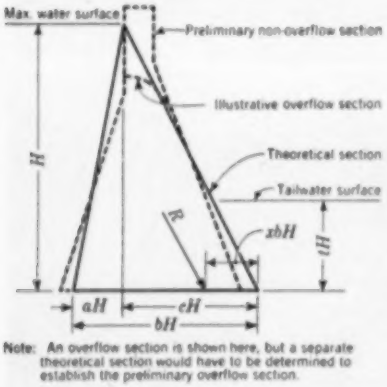
Office of the District Engineer, Baltimore, Md.

Preliminary sections of gravity dams are needed for the preparation of estimates and determination of the most economic shape of the dam. The equations developed here are based on making the dam safe against sliding (using foundation friction only) and safe from overturning (keeping the resultant near the third point of the base). Uplift on the base was assumed to be the full head of the pool at the heel and the full head of the tailwater at the toe, acting on a fraction, u, of the base area. Concrete was assumed to weigh 150 lb per cu ft and water 62.5 lb per cu ft.

These equations are flexible and comprehensive. The usual procedure for establishing the economic sections would be to determine the non-overflow section without tailwater by Eq. 1; and then the overflow and the non-overflow sections with tailwater by Eq. 2, using the same value of c obtained above in Eq. 1. However, in cases where conditions other than economy establish either the upstream or the downstream slope, the alternate slope for sections with tailwater can be determined by Eqs. 2 and 4, and the alternate slope for sections without tailwater can be determined by Eqs. 3 and 4.

Equation 1 is considered the most useful. By its use the most economic shape and the minimum section of



Note: An overflow section is shown here, but a separate theoretical section would have to be determined to establish the preliminary overflow section.

FIG. 1. Theoretical section developed by applicable equations is shown in solid lines. After determining the theoretical section, visually establish the practical preliminary section (in dashed lines) which is similar in shape and area to theoretical section.

Nomenclature

$f = \frac{\Sigma H}{\Sigma V}$ = coefficient of friction of foundation, or sliding factor

u = fraction of base area on which uplift is fully effective. (Total uplift with no tailwater = $(u\ b\ h^2)/2$.)

t = ratio of tailwater depth to pool depth

c = 1.0 for non-overflow section with tailwater

c = 0.6 ± for overflow section reflecting turbulence downstream

a, b, c = fractions as indicated in Fig. 1

For other terms, see Fig. 1

the dam (Fig. 1) can be determined immediately without resorting to numerous computations by trial and error. The values determined by Eq. 1 satisfy the requirements for both sliding and overturning for the non-overflow section with no tailwater.

Minimum section

Because of its importance, Eq. 1 is presented here although it was derived from Eqs. 3 and 5.

To find the minimum section, non-overflow, with no tailwater, determine f and u by test or assumption. Make $c = f$, and compute a from

$$a = \frac{1 - [(2.4 - u)f^2]}{(3.4 - u)f} \quad . \quad (1)$$

A non-overflow section with no tailwater, with these values of a and c, is exactly correct for sliding, and the resultant falls at or slightly inside the third point of the base, which indicates an economic (minimum) section. For non-overflow sections with tailwater and for overflow sections, it is recommended that c be made equal to f, and a computed by Eq. 2.

Computing coefficient of friction

To compute the coefficient of friction of the foundation, or the sliding factor, f, for overflow and non-overflow sections with tailwater, take $f = \frac{\Sigma H}{\Sigma V}$. Then it can be shown that $f =$

$$\frac{1 - ef^2}{(3.4 - u - ut)a + (2.4 + ef^2 - u - ut)c} \quad . \quad (2)$$

For sections with no tailwater, where $t = 0$, then

$$f = \frac{1}{(3.4 - u)a + (2.4 - u)c} \quad . \quad (3)$$

Determining position of resultant

Equation 4, used to determine the value of x, is exact when $t = 0$ and is a close approximation when t is less than 0.5. To compute the resultant position formula (for no tailwater), take $xbh = \frac{\Sigma M_0}{\Sigma V_1}$, from which it may be shown that

$$x = \frac{(1 - u)b^2 + 2.4ac + 1.4c^2}{3} \quad . \quad (4)$$

if $x = {}^1/_2$ then

$$(1 - u) + 2.4ac + 1.4c^2 = 1 \quad . \quad (5)$$

Derivation of Eq. 1 for non-overflow and no tailwater

When $u = 1$, from Eq. 3

$$f = \frac{1}{2.4a + 1.4c}$$

or $$2.4af + 1.4fc = 1$$

Also, from Eq. 5, $2.4ac + 1.4c^2 = 1$. Therefore $c = f$ when $u = 1$ and the section is evenly balanced for sliding and overturning.

When $a = 0$, which is the case for low values of u, from Eq. 3,

$$f = \frac{1}{(2.4 - u)c}$$

or $$(2.4 - u)cf = 1$$

Also, from Eq. 5, $(2.4 - u)c^2 = 1$. Therefore $c = f$ when $a = 0$ and the section is evenly balanced for sliding and overturning.

It has been found by trial that for intermediate values of u, c is very nearly equal to f, in the most economic section. Therefore if c is made equal to f and a is computed from Eq. 3, a most economic section will result.

When $c = f$, Eq. 3 can be converted to Eq. 1. For abnormal values of f and u, Eq. 1 will give a negative value for a. Disregard it and obtain the economic section as follows:

$$\text{Let } a = 0 \text{ and } c = \sqrt{\frac{1}{2.4 - u}}$$

Example for use of Eq. 1, for condition of non-overflow, no tailwater

Given the allowable coefficient of friction, $f = 0.68$, and full uplift on two-thirds the base area, that is, $u = 0.666$.

For the most economic section, let $c = f = 0.68$. From Eq. 1,

$$a = \frac{1 - (2.4 - 0.666) \times 0.68^2}{(3.4 - 0.666) \times 0.68} = 0.11$$

$$b = a + c = 0.79$$

Conclusion

As there are many factors to be considered in the design of a dam not included here (such as earthquake and ice conditions), these findings must be used with judgment. However, if the dam is subjected to the assumed loading conditions used in making this analysis, it is concluded that the economic theoretical section is obtained for all types of sections by making $c = f$, and finding the value of a from the applicable equation. In view of the lack of universal agreement on some basic assumptions, especially uplift, these equations are considered sufficiently accurate for preliminary sections, for a rough check on final design computations, and for the determination of the most economic shape of the dam.

THE READERS WRITE

Excluding silt from diversion channels involves complex problems

TO THE EDITOR: The design of headworks for the diversion of water from a main canal, as described by Serge Leliavsky in his article, "Sloping-Sill Sand Screens Exclude Silt from Egyptian Irrigation Canals," in the March issue (p. 70), does not take care of all the hydraulic conditions involved in this problem.

The main parameter, the angle of deflection, expressing the intensity of the centrifugal force, is a handy empirical formula. But elaborate tests by Bulle, Schocklitsch, Habermaas, and others demonstrate that the intensity of the centrifugal force is not a specific factor affecting the amount of entering sediments. For instance, Bulle found that the amount of sediments entering the diversion in non-erodible channels, maintaining the diversion ratio of flow at 0.5 and varying the deflection angle from 30 to 150 deg, was a maximum (97 percent) at the 30-deg angle and always exceeded 87.5 percent of the total amount of sediment entering the approach channel.

Consequently reversing the slope of the sill alone is insufficient to solve this complex problem. The entrance of silt into the

diversion channel is influenced by a variety of conditions such as the diversion and depth-width ratio, deflection angle, velocity and depth variations, boundary alignments, conveyance characteristics of the diversion channel, and particularly by the alignment of the main channel upstream. A. Schocklitsch found that, under certain conditions, even a sill sloping downstream was more efficient (*Hydraulic Structures*, American Society of Mechanical Engineers, 1937).

If the sediments in front of the sill cannot be removed by sluicing, the only possible way to improve the situation is to produce and utilize a secondary current which will deflect the sediment-laden bottom layers away from the diversion entrance. Otherwise any sill, either sloping or horizontal, can be crossed over by means of a ramp of deposits.

The best location for a diversion intake, to secure minimum entrance of silt, is at the end of the concave side of a bend. The definite advantage of this location is due to the secondary current, which is generated by the unbalanced centrifugal forces in the cross section of the approach channel as a result of the slow velocity of the bottom layers. This kind of flow pattern is often induced by incorporating an S-curve into a straight channel or separating the diversion water by curved guide walls, as shown by model tests by H. M. Martin and E. J. Carlson ("Model Studies of Sediment Control Structures on Diversion Dams," *Proceedings*, Minnesota International Hydraulics Convention, 1953, p. 109).

Theoretically there is another possible method of improving the performance of a diversion structure by balancing the centrifugal forces locally in the bend to the intake. This would reduce the otherwise disproportionate volume of sediment-laden bottom layers entering the headworks.

The basic formula for the change of centrifugal pressure in curved flows is:

$$\frac{dp}{dr} = \frac{\rho V_t^2}{r} - \rho V_r \frac{dV_r}{r\,dk} \quad . \quad . \quad . \quad .(1)$$

in which, p = centrifugal pressure

r = radius of flow filaments

ρ = density of fluid

V_t = tangential velocity

V_r = radial velocity

k = deflection angle

The flow along the bend follows approximately the potential flow pattern, with a velocity,

$$V_t = \frac{c}{r} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad .(2)$$

in which c is a constant.

Replacing V_t in Eq. 1 by c/r, and neglecting the second member as too small, the radial pressure change in a bend becomes

$$\frac{dp}{dr} = \frac{\rho c}{r^3} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad .(3)$$

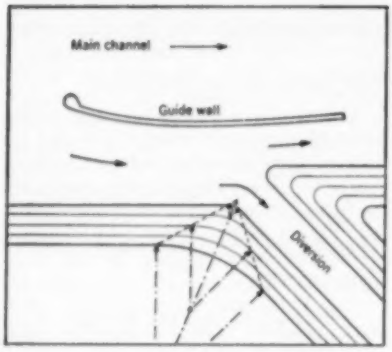


FIG. 1. Arrangement of curved guide wall and upstream embankment of intake, designed to reduce volume of sediments entering diversion channel. Contour lines show reduction of embankment radius toward the bottom.

and the total radial pressure difference between the side walls is

$$\Delta p = \rho c \int_{r_2}^{r_1} \frac{1}{r^3}\,dr \quad . \quad . \quad . \quad .(4)$$

It is obvious that the value of Δp may be kept constant in cross section by decreasing the radius, r, of flow near the bottom to offset the reduction of c due to friction. In this way it seems possible to eliminate the unbalanced centrifugal force in the bend to the intake which produces the secondary current which is detrimental there.

A good arrangement for deflecting sediment-laden currents from the entrance to a diversion channel is shown in Fig. 1. The guide wall is curved and the upstream embankment of the intake has a greatly reduced radius at the bottom.

HAROLD TULTS
Assistant Hydraulic Engineer
Pioneer Service and Engineering Co.
Chicago, Ill.

Stirrup spacing method widely publicized

TO THE EDITOR: It may be of interest to mention, in connection with the article by Jack Moyse (CIVIL ENGINEERING, October 1953, p. 62) and the letter to the editor by Robert A. Hoff (ibid, February 1954, p. 61), that articles presenting a similar method of determining stirrup spacing have appeared in the *Journal* of the American Concrete Institute for June 1953 and January 1954.

The writer wishes to add to the record that he was one of the legion who derived the method of equal areas for trapezoids independently during the latter part of 1938 and January 1939. This method, along with several others, has been in use in our office since that date and has been taught to night-school classes. It was not published because William J. Larkin, Jr., M. ASCE, presented his article to the press at about the same time. Entitled "Spacing of Stirrups in Reinforced Concrete Beams," it appeared in CIVIL ENGINEERING for June 1939 (p. 368).

Since 1939, the writer has seen at least two other presentations, one in the A.C.I. *Journal* and an extensive article in *Wood Preserving News* by I. A. Schecter. The last mentioned article presents a graph.

The writer's own method is applied by a table of q values, where $q = A_s f_s jd$ (for U-stirrups). These values are tabulated for No. 2, No. 3, and No. 4 bars and make allowance for the inadequate bond lengths on older type bars in shallow beams. Then the required number of stirrups is $2N = (V's)/q$ for triangular shear areas. $V' = V - V_c s$ = the length, in inches, requiring stirrups. By slide rule, set $2N$ on the B-scale over s on the D-scale, and read below each odd number on the B-scale the s increment on the D-scale.

The following example will clear the atmosphere:

B-SCALE $2N$	D-SCALE s	SPACING FOR 6 STIRRUPS
12	80	3 in.
11	77	7
9	70	9
7	61	9
5	52	12
3	40	17
1	23	23

Maximum spacing may be $d/2$. Always read the nearest unit above any fractional number such as 70 in the example. This method and the writer's table can be used for various loadings, since the spacing at any point is equal to $s = q/V'$ (at the point).

By writing the spacing over the shear diagram, the spacing for intermediate stirrups can be estimated. Also, this method can be used to space a fractional number of stirrups. This latter is too refined, but is mentioned in passing for use in other fields. For some cases, s can be scaled, but usually the writer uses $(12\ V')/w = s$, and proceeds directly to N. (w = uniform load per ft.) Some designers feel that this is too refined and will compute s at the support and then by inspection write the spacing at the quarter, half, and three-quarter points of the shear triangle.

ALLEN H. BROWNFIELD, A.M.ASCE
Sacramento, Calif.

Was mirror-like globe used as surveying instrument?

TO THE EDITOR: A mirror-like globe has come down in our family from my grandfather, Thomas Doane, long a member of ASCE. It is called, I believe, a heliograph or heliostat. This instrument (which is now in the possession of Doane College at Crete, Nebr.) is a sphere 12 in. in diameter, made of very light material and apparently silvered, for reflection, as a mirror. On the cylindrical collar or "neck" appear the words (as nearly as can be deciphered):

"E. Varnish Cox
Patent
London"

My grandfather was the chief engineer on the Hoosac Tunnel in Massachusetts, completed in the 1870's, and according to family tradition this was the instrument used in the control surveys that resulted in a closing error of less than $^5/_8$ in. in a tunnel 5 miles long.

This inquiry is instituted in the hope that one of your readers will be able to identify this type of instrument from the accompanying photograph and possibly explain its operation as a tool useful to engineers.

THOMAS DOANE PERRY
Fellow, ASME

Moorestown, N.J.

Editor's Note: Extensive search in patent files—both American and British—and correspondence with acknowledged authorities on surveying instruments, has failed to solve the mystery surrounding this instrument. What is its origin? How does it work? All information from members will be received at ASCE Headquarters with interest.

Lateral stability of prestressed concrete beam could have been calculated

TO THE EDITOR: I read with interest the article by Robert E. Snetzer on the long-span prestressed concrete beams used in an Army field house in Germany (April issue, p. 41). It seems to me that the limberness of the beams which caused the loss of one of them in handling could have been anticipated.

The accompanying Fig. 1 presents the cross-section of the beams at center of span with dimensions as I understand them from Mr. Snetzer's article. Using the gross cross-section, and without trying for accuracy, I get for the moment of inertia about the Y – Y axis, roughly 5,200 in.^{4}; for the area, 500 in.^{2}; and for the radius of gyration, 3.22 in. With the given span of the beam 102 ft, this yields:

$$\frac{L}{r} = \frac{102 \text{ ft} \times 12 \text{ in. per ft}}{3.22 \text{ in.}} = 380$$

without considering the increase in r toward the ends of the beam (due to the varying cross-section).

Considering the concrete section of the beam to be a column axially loaded by the prestressed steel, and using Euler's formula for critical P/A:

$$\left(\frac{P}{A}\right)_{\text{critical}} = \frac{\pi^2 E}{(L/r)^2}$$

taking $E = 1000\ f'_c$ (A.C.I. Code), I get as

$$\left(\frac{P}{A}\right)_{\text{critical}} = \frac{\pi^2 \times 1{,}000 \times 7{,}000 \text{ psi}}{380^2} = 480 \text{ psi}$$

while the actual axial load is

P = 3.42 in.^{2} × 120,000 psi (assumed dead-load stress in steel) = 410,000 lb and as

$\frac{P}{A}$ = 820 psi, or about 1.7 times the critical $\frac{P}{A}$.

Of course this application of the slender-column formula to a prestressed beam is somewhat arbitrary. The prestressed beam has the advantage of the support given by the prestressing cable, which seeks to remain straight. Also, unlike a failing column, the prestressed beam is not subject to increased eccentricity, with accompanying destructive bending moment, as the deflection increases. This probably explains the peculiarly interesting equilibrium condition, where, as described in the article, a man at the center of one of these beams could easily move it back and fourth.

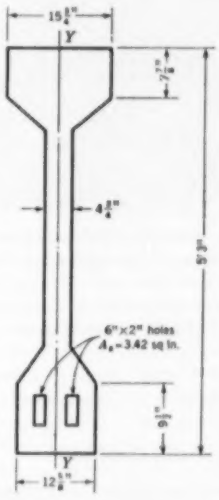


FIG. 1. Beam cross-section at center of span shows dimensions on which calculations are based. Flange dimensions of $7^7/_{16}$ in. and 9 in. may have been meant to indicate mean thickness, but difference in value of r would be small.

There may be other and better methods for calculating the lateral stability of prestressed concrete beams, but even this rather crude method ought to give a good idea of what to expect when methods of erection are considered.

UNO KULA, J.M. ASCE

Brooklyn, N.Y.

Author concurs in advisability of precalculating stresses

TO THE EDITOR: I find Mr. Kula's letter, explaining his method of calculating the overstress in the beam in terms of Euler's formula, most interesting. It is, as he suggests, an approximate solution, but one it would have been wise to use before the first beam was raised.

Actually the beam was picked up under the supervision of the job foreman without thought of the limberness of the member. On previous jobs he had erected many similar beams—similar, that is, except that none of them had been as long or had had such a slenderness ratio. The design engineer had not considered the erection procedure; he had left that to the erector.

The form of the beam, with its camber in the bottom chord and roof pitch in the top chord, made the center higher than the ends, raising the center of gravity so as to require a special lifting procedure in any event. The steel truss developed for handling these beams worked out very effectively and would be recommended for any similar situations.

ROBERT E. SNETZER, A.M. ASCE
Lt. Col., USA (CE), Development Division, Field Command
Albuquerque, N. Mex.

SOCIETY NEWS

ASCE Problems Studied at Large West Coast Conferences

Plenty of opportunity for group discussion of Society affairs at local level and for study and inspection of new engineering works, with emphasis on West Coast projects, was provided members attending two large-scale spring conferences of West Coast Sections—the Seventh Annual Pacific Southwest Conference (the former California Conference), held in Sacramento, Calif., April 28–May 1, and the Sixth Annual Pacific Northwest Conference held in Spokane, Wash., April 23 and 24.

Pacific Southwest Conference

The unprecedented attendance of 850 at the Pacific Southwest Conference, to which the Sacramento Section was principal host, included Society officers and members of the Executive Committee of the Board of Direction which met during the conference. The banquet and both luncheons were sold out hours ahead of time, and the technical sessions drew such crowds it was necessary to move several times to find rooms large enough to accommodate them.

ASCE President Daniel V. Terrell addressed the conference banquet on Society affairs, with emphasis on the need for increased service to the membership. Presentation of student prizes to winners in the annual student paper contest was another banquet feature. The winners chosen out of a field of ten were Milton Sharp, of the University of Nevada, who received first prize for a paper on "Preliminary Planning for a Student Union Building"; C. R. Miller, of the University of Arizona, who was awarded second prize for a paper on the St. Lawrence Seaway and Power Project; and Francis W. Joyce, of California Institute of Technology, who received third prize for a paper entitled "Stabilometer-Pressure Swell Method of Road Base Design."

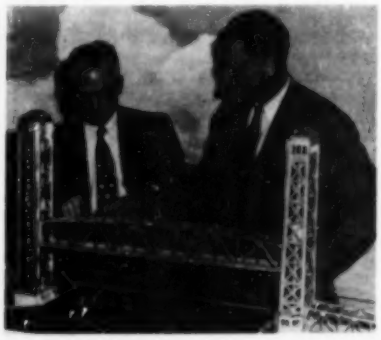
Organization of Local Section technical divisions, organization and operation of Subsections, procurement of professional engineering services, employer-employee relations, and professional registration examinations came in for considerable discussion. Among local technical problems and projects studied in a dozen or more technical papers were the Etiwanda Steam Plant; Pit No. 4 Project of the P.G. & E. Co.; water and power from the upper Colorado River; the Richmond–San Rafael Bridge; the Sacramento Sewage Treatment Plant; and Folsom Dam. The two latter projects and the Bureau of Reclamation's Nimbus Afterbay Project were visited during the Saturday excursion and picnic that concluded the program.

R. Robinson Rowe (N.G. Neare to readers of CIVIL ENGINEERING) was general conference chairman, and Stewart Mitchell was technical program chairman. Hosts, in addition to the Sacramento Section, were its four Subsections (Central Valley, Marysville, Nevada, and Shasta), its Junior Forum, the Sacramento Speakers Club, and the University of Nevada Student Chapter.

Executive Committee Meeting

Actions taken by the ASCE Executive Committee during its Sacramento meeting included authorization for the formation of a Committee of Five Presidents, consisting of the current president of each of the EJC constituent societies, for the purpose of expediting selection of a location for a new engineering center and settling the other questions necessary for a joint decision by the boards of the five societies (item on page 75). A similar resolution asks United Engineering Trustees to inform the Committee of the Five Presidents of progress made to date in obtaining an engineering center, and requests UET to coordinate its operations with those of the committee.

After extended discussion the Committee requested the President of ASCE to communicate promptly with Gov. James F. Byrnes of South Carolina suggesting, in the public interest, that he direct his Highway Department to discontinue immediately its practice of calling for bids for obtaining professional engineering



More than 200 enjoyed the all-day excursion, culminating feature of the Pacific Southwest Conference. Shown picnicking at Folsom Dam are (in usual order) Mrs. G. Brooks Earnest; Finley Laverty, of Los Angeles; Walter Schulz, chairman of the Conference Interim Committee; Mrs. George B. Gleason, chairman of the Friday Ladies' Tour; ASCE President Daniel V. Terrell; and Mrs. Finley Laverty. R. Robinson Rowe, general conference chairman, is pictured (left in right-hand photo) with Mr. Schulz. They are inspecting one of a number of engineering models that were on display during the conference.

Viewed at the luncheon meeting during the Pacific Northwest Conference are (left to right in left-hand photo): Mason G. Lockwood, ASCE Vice-President, Zone IV; Fred H. Rhodes, of Seattle, retiring conference chairman; Arthur J. Davidson, president of the Spokane Section; Charles Carroll, president, Spokane Chamber of Commerce; and Harold J. Doolittle, newly elected conference chairman. The photo at the right, taken during the evening banquet, shows (in the usual order) Horace J. Whitacre, Jr., Tacoma, vice-chairman; Harold J. Doolittle, 1955 conference chairman; and J. Bryan Barber, Spokane, conference secretary-treasurer

services and to secure future engineering services required on a professional and ethical basis. The text of the telegram sent to Governor Byrnes and discussion of action developing from it are given on page 74.

Executive Committee appointments included the reappointment of Executive Secretary W.N. Carey as one of the three ASCE Trustees on UET for a four-year term.

Pacific Northwest Conference

Members of the Society from the Seattle, Tacoma, Oregon, Columbia, Southern Idaho, and Montana Sections were guests of the Spokane Section for the sixth annual spring meeting of the Pacific Northwest Conference. The official registration of 126 was augmented by a large family and student attendance. During the conference business meeting Harold J. Doolittle, of Spokane, was elected conference chairman for the coming year; Horace J. Whitacre, of Tacoma, vice-chairman; and J. Bryan Barber, of Spokane, secretary-treasurer. Fred H. Rhodes, Jr., of Seattle, is retiring chairman, and Hamilton K. Johnson, of Seattle, retiring secretary-treasurer.

Featured speaker at the Friday luncheon was ASCE Vice-President Mason G. Lockwood, of Houston, Tex., who reported on the general status and affairs of the Society. A panel of experts representing the power, lumbering, light metals, agriculture, and mining industries took part in a Power and Industry Symposium, presenting the views of their various fields and relating their fields of endeavor to the economic growth and welfare of the Pacific Northwest. In further development of the conference theme, the after-dinner speaker, Orren Brownson, assistant administrator of the Bonneville Power Administration, discussed "The Effects of Power on Industrial Development." Many students attended the banquet as the wind-up to their own conference at Washington State College, Pullman, Wash.

A whole day was devoted to field trips. One trip, attended by 120, included the Fairchild Airforce Base and the Kaiser Aluminum and Chemical Company's huge Trentwood aluminum rolling mills. The other trip took some 60 engineers into northern Idaho for inspection of Albeni Falls Dam on the Pend Oreille River and Cabinet Gorge Dam on the Clark Fork River.

All conference arrangements were handled by a special committee headed by Thomas Judd, of Spokane, and by Arthur J. Davidson, of Ephrata, president of the Spokane Section. Mrs. J. P. Esvelt is president of the Spokane ASCE Ladies. The 1955 conference will probably be held in Tacoma, Wash.

ASCE Protest Against Bidding for Engineering Services Rejected by S. C. Highway Department

In a telegram to Gov. James F. Byrnes, of South Carolina, the Executive Committee of the Board of Direction, at its meeting in Sacramento on May 1 during the Southwest Conference of Sections, protested the recent action of the State Highway Department in advertising for competitive bids for engineering services as unprofessional and opposed to the public interest. Though the telegram strongly urged cancellation of the Highway Department's plans to take bids at Columbia on May 11, fourteen bids were opened on that date on six bridge projects totaling $3,500,000 in construction costs. On earlier projects a $500,000 award was made to the low bidder.

A spokesman for the department, which is headed by Claude R. McMillan, M.ASCE, stated that because its engineering staff was small it had to go outside for plans and that its own engineers would supervise construction, assuring the work would meet department standards.

This stand has been assailed by ASCE in a statement released to the press by Executive Secretary Carey. His statement does not deny, in fact it affirms, that it is advantageous to obtain outside engineering firms to develop bridge designs and specifications. It does, however, emphasize that "It is not advantageous to the people of South Carolina, who foot the bill, to permit their Highway Department to give these engineering design jobs to the engineers who promise to make them for the lowest fees.

"The engineer who takes a design job on a price-competition basis is forced to cut corners in developing the design, while still producing a bridge which probably will carry the loadings required by the Highway Department. But to expect such a bridge to be designed so as to carry its

loads with the most economical use of steel and concrete is wishful thinking, as every informed bridge engineer knows.

"The proper design of a large bridge is dependent on engineering judgment and skill of a high order plus an inordinate amount of work on the part of the men charged with the detailing of every beam, girder, splice, rivet, and reinforcing bar going into the final structure. Cheap design almost always results in what engineers call 'over-design.' "

In explaining "over-design," the statement continues, "Because the man who furnishes a design on a cut-price basis cannot afford to take the time needed to work out the best design possible, he will use more tonnage of steel, more cubic yards of reinforced concrete, more of other materials than necessary, in order that his cheaply designed structure will be able to carry the required loads. What the taxpayer saves on a cheap design he pays out many times over to the contractor in the cost of the construction contract."

Text of Telegram

The telegram authorized by the Executive Committee and sent to Governor Byrnes reads as follows:

"The Board of Direction American Society Civil Engineers believes highway department your state not best serving public interest in securing professional engineering services through competitive bidding procedures. Urge you personally read letter to you April 23rd, with enclosures from James Higgs, Atlanta, Georgia, Chairman ASCE Committee Professional Conduct. Unprofessional procedures your highway department already have disclosed situation which could result in expulsion your chief highway commissioner and several engineer bidders from American Society Civil Engineers. Recommend strongly your May eleventh lettings for professional engineering services be cancelled and that highway department use procedures customarily followed by federal government, states, turnpike authorities, and other public bodies for securing professional engineering services in accordance with accepted ethical practices. South Carolina will obtain same quality engineering services through competitive bidding as it would legal services obtained in same manner. High construction costs always follow cheap design. This telegram directed by Executive Committee Board ASCE at meeting in Sacramento, California, April 29th."

May 11 Bid Openings

According to a report in a May 12 edition of the newspaper *The State*, published in Columbia, S.C., bids were opened on May 11. On the design of five Charleston County bridges, seven engineering firms submitted bids based on a percentage of construction contract costs. The percentage amounts were: 1.40, 1.60, 1.94, 2.20, 2.63, 3.0, and 3.0 percent. For the design of one bridge in Beaufort County bids from the same seven firms were opened, the percentage amounts being 1.90, 2.24, 2.40, 2.63, 2.80, 2.85 and 3.20 percent. The list of bidders on these six bridges is a public record. It is believed that interested persons can obtain the list from L. C. Moltz, Office Engineer, South Carolina Highway Department, State Highway Building, Columbia, S. C.

Structural Conference Held in Kansas City

The First Structural Conference, sponsored jointly by the ASCE Structural Division and the Kansas City Section, was enthusiastically received by the members taking part in the two-day program, which was held in Kansas City, May 13 and 14. All six sections in District 16 were represented in the attendance of 450. Those who initiated the conference and carried it through can take credit for the enthusiastic reception accorded the program which packed the meeting rooms. Waldo R. Kell was chairman of the hard-working conference committee, and the host (Kansas City) Section was piloted by President Richard R. Tipton.

Ten technical addresses featuring new theories and techniques vied for attention with a luncheon address by William E. Kemp, mayor of Kansas City, and an after-dinner speech by C. Earl Hovey, a patent attorney who has worked closely with engineers. The practical aspects of vibration design of structures were studied in the paper opening the first day of the conference, devoted to general structural theory and practice. H.H. Benjes, head of the civil engineering department, Black & Veatch, produced conclusions gained from study of action of rotating machines on structures. A second paper by Leo D. Boswell, structural designer for Burns & McDonnell, presented design procedures through application of "flexibility factors" to moment distribution.

In a second session Adrian W. Pauw, associate professor of civil engineering at the University of Missouri, revealed new data on performance of lightweight aggregates for structural concrete. Concrete was the theme also of a paper by Mario G. Salvadori, professor of civil engineering at Columbia University, entitled "Structural Imagination—the Design and Construction of Thin Shells." The imagination was stimulated, indeed, by Professor Salvadori's presentation. Basic consideration of foundation design essential to stable structures was the subject covered by Karl V. Taylor, U.S. Corps of Engineers. Settlement causes and corrections were detailed.

Highway structures was the general theme of the second day of the conference, which featured papers by C. H. Scholer, professor of applied mechanics at Kansas State and new president of the ACI, on "Prestressed Concrete, Pro and Con"; Frank M. Kerekes, assistant dean of engineering at Iowa State College, entitled "Distribution of Wheel Loads to Bridge Stringers"; and Henry G. Schlitt, deputy state engineer of Nebraska, on "Precast Concrete Bridge Units."

Two papers described the planning and design of the new Paseo Bridge under construction over the Missouri River which was the objective of a field trip. These were prepared by R. N. Bergendoff and Jacob Karol, both with Howard, Needles, Tammen & Bergendoff, consultants on this major project.

Speakers' table at dinner held during the recent First Structural Conference in Kansas City shows, in usual order, Mrs. Reed McKinley; Mr. McKinley; Miss Helen M. Skelton; Richard R. Tipton, president of Kansas City Section; George E. Brandow, Los Angeles consultant and representative of the executive committee of the ASCE Structural Division; Mrs. Theodore J. Cambern; Mr. Cambern; Mrs. Waldo R. Kell; and Mr. Kell, conference chairman. The executive committee of the Structural Division was also represented at the conference by Prof. Warren Raeder, head of the civil engineering department at the University of Colorado.

Changes in EJC Staff Announced

Brig. Gen. Stewart E. Reimel (retired), M.ASCE, was appointed to succeed T. A. Marshall, Jr., in the post of secretary of Engineers Joint Council on April 16. Since his retirement from the regular

General Reimel

Army in 1946, after 29 years of service, General Reimel has been consultant on machine tools to the National Security Resources Board, the Defense Production Administration, and the National Production Authority, in Washington, D.C. He is the holder of the French Legion of Honor and the Distinguished Service Medal.

General Reimel will be assisted by E. Paul Lange. Mr. Lange is a graduate of the University of Washington, and has been with C. Tennant Sons & Co., for the past four years, and previously was working for the Saudi Arabian government. In his capacity of executive secretary of the Engineering Manpower Commission of EJC, Mr. Marshall will be succeeded by William T. Cavanaugh, formerly assistant secretary.

Irrigation Conference Scheduled for September

To provide for exchange of information in the field of irrigation and drainage, the ASCE Irrigation and Drainage Division is making plans for a three-day conference in Salt Lake City, Utah. Engineers planning to attend should mark on their calendars the dates, September 16, 17 and 18, 1954. A detailed program will be released soon by Conference Chairman George D. Clyde, Logan, Utah.

Advantages of Manhattan for Engineering Center Studied

The possibility of keeping the proposed Engineering Societies Center in New York was discussed at a meeting of the United Engineering Trustees held on April 21, with W. F. Thompson, an ASME representative on UET, offering for consideration some estimates of probable costs of retaining the Engineering Societies Building in Manhattan. He also discussed a proposal of the ASME, which calls for an office in New York City and a "Work Center" in some town in the metropolitan area but outside the city.

Such a center, it is contended, would coordinate the publishing and other behind-the-scenes operations of the societies, permitting them to be carried out at reduced costs. Other scientific organizations in the metropolitan area have grouped together in a work center. With most of the personnel located in such a center, the proposed New York office of the participating societies, it is estimated, need not be larger than 18,000 to 20,000 sq ft.

Since the UET meeting Commissioner Robert T. Moses has offered the Engineering Societies an opportunity to purchase at a low figure a highly suitable site in connection with the redevelopment of the Columbus Circle area in the city.

To aid UET and the participating societies in selecting a site and in settling the many problems involved, the ASCE Executive Committee, at its Sacramento meeting on May 1, authorized formation of a Committee of Five Presidents. The committee, which has also been authorized by the other societies, consists of the current president of each of the five EJC constituent societies. The five presidents are Daniel V. Terrell, Lexington, Ky., ASCE; Leo F. Reinartz, Middletown, Ohio, AIME; Elgin B. Robertson, Dallas, Tex., AIEE; Lewis K. Sillcox, Watertown, N.Y., ASME; and D. G. Kirkbride, Philadelphia, Pa., AIChE. They will constitute a permanent committee.

The Real Estate Committee of UET has been requested to develop two propositions with recommendations: (1) a multi-story building in New York City and (2) a low building in a large area at any location. That report is to be presented to the Committee of Five Presidents for its consideration. W. N. Carey has been named Chairman of the Real Estate Committee of UET, vice R. F. Gagg, ASME, who has resigned.

EJC Urges More Use of Engineers in Atomic Developments

Fuller participation in atomic energy developments by both the engineering profession and private industry was urged by Engineers Joint Council in a recent letter to the Hon W. Sterling Cole, chairman of the congressional Joint Committee on Atomic Energy. Signed by EJC President Thorndike Saville and dated May 12, the letter reaffirms the stand taken by EJC last July in recommending changes in the Atomic Energy Act to permit maximum use of both engineers and private industry in the development of peacetime applications of atomic energy.

Noting that while marked progress has been made since last July in the application of engineering science to nuclear energy, the letter emphasizes anew the necessity for revising the present law to permit broadened participation in the development of atomic energy. Such "fuller participation by both the engineering profession and private industry," it says, "should mean much toward improving the situation in those countries overseas closely allied to us." The events of the past year, it concludes, "provide still greater justification for Council's stand on the Atomic Energy Act."

In its original statement, prepared last July, EJC made the following recommendations as providing "a framework within which engineers can become effective":

"1. The law should provide for issuance of appropriate licenses, under conditions defined later, to organizations to develop, manufacture, own, and use facilities for producing or using heat and radiant energy from atomic fuels, together with production and sales of radioactive products such as atomic fuel produced therein.

"2. A workable system of making source, fissionable, and feed materials available at a price to all licensed organizations as needed. It is doubtful that there will be enough actual requests to offset the nation's defense requirements.

"3. One of the traditional American incentives, patents, should be revitalized. This is one kind of incentive motivating individual engineers and engineering groups."

EJC calls such recommendations "basic to provide engineers with places in which to develop, for business to have the incentive to manufacture what they [engineers] develop, for feed materials to be available to operate and prove equipment, so that results can be determined and then improved upon."

Regional Spring Conferences Mark End of Student Chapter Year

As usual ASCE Student Chapters in all parts of the country are ending the school year with lively conferences devoted to student paper competitions, inspection trips, and (perhaps primarily) study of the perennial problem of how to get a job and keep it. Reports of several of the conferences have been received at Society headquarters and are summarized here.

The Pacific Southwest Conference of Chapters, held in Sacramento, May 1, is summarized in the story of the conference (page 72).

Middle Atlantic Conference

Swarthmore College was host to the fifteenth annual Middle Atlantic Conference, held on April 26 and attended by 310 delegates from ten schools in the region. The group was welcomed by Horace A. Reeves, Jr., president of the host Chapter, and Joseph B. Shane, vice-president of Swarthmore, and the presidents of the sponsoring Sections (Philadelphia, Delaware, and Lehigh Valley) responded suitably. In the key message of the morning session, Allen P. Richmond, Jr., assistant to the Secretary of ASCE, threw new light on the topic, "The Role of the Student Chapter." Mr. Richmond emphasized the "great opportunity" as well as the obligation Student Chapters have to help engineering students become acquainted with the profession they will enter.

Villanova University took top honors in the technical paper competition, with Dwight A. Zink and William B. Wagner the first-prize winners for their paper on "An Investigation of Pretensioned and Post-tensioned Concrete Slabs." Second prize went to Constantine Inglessis, Layiwola Shoyinka, Thomas Simkin, and Gordon Smith, of Swarthmore, for a paper on "Wind Tunnel Studies of Pressure Distribution on Roofs of Simple Block-Type Structures"; third prize to W. H. Lamb and J. R. Phillips, of Lehigh University, for a paper on "Bolted Connections"; and fourth prize to Vaughn R. Parfitt, of Drexel Institute, for a paper entitled "A Portion of an Analysis of a Bascule Bridge Tower." Richard Jenney, chairman of the judging committee, presented the prizes at a luncheon that concluded the morning program.

Delegates arriving on the eve of the conference had a chance to hear the first in a series of three lectures presented by the Cooper Foundation of Swarthmore, on the subject, "City Planning and the Citizen," given by Robert Mitchell, of the University of Pennsylvania. A social get-together at the home of Prof. Roy F. Linsenmeyer, Faculty Adviser, followed the lecture.

New England Conference

The University of Rhode Island and the Society's Student Chapter there entertained 110 representatives from 12 of the 15 Chapters in the New England Conference of Student Chapters, May 1, at Kingston, R.I. Speakers heard during the day were Edgar P. Snow, president of the C. W. Riva Co., whose subject was "Vehicular Tunnel Construction," and Fenton G. Keyes, Providence consultant, who talked on "Opportunities in the Consulting Field."

In the annual student paper competition, first prize ($20 and Junior membership in the Society) was awarded to Roger Wildt, of Worcester Polytechnic Institute, for a paper on "A Welded Fire Escape"; second prize ($10 and Junior membership) to J. Norman Welch, of Northeastern University, for a paper on "Vertical Sand Drains"; and third prize (Junior membership) to Robert J. Assenzo, of Northeastern, for a paper on "Water Storage". Honorable mention went to three other Northeastern Chapter members—Elton Fuller, Robert S. Esterberg, and William J. Kelly.

At a banquet held in the evening under the auspices of the Providence Section a demonstration entitled "Television Skyways," was given by Samuel G. Stiness and John F. Fogarty, of the New England Telephone and Telegraph Co.

North Central Conference

The keynote address of the North Central Conference, held at the University of Cincinnati, April 14–16, was given by ASCE President Daniel V. Terrell, who commented on the value of the Chapters to the Society and, conversely, on the value of the Society to Chapter members. Other aspects of Student Chapter operation were discussed by Prof. George W. Bradshaw, head of the Committee on Student Chapter Affairs. Speakers at the general opening session were Archie N. Carter, highway division manager for the Associated General Contractors of America, Inc., whose subject was "America Progresses Through Construction," and William G. Hamlin, sanitary engineer for the Ohio River Valley Sanitation Commission, who discussed the set-up and work of the Commission. A tour of the Proctor and Gamble plant, executive sessions, and an evening banquet and entertainment concluded the opening-day program.

Friday morning was devoted to conference affairs—a man-mile trophy award, student paper awards, and the reading of winning papers—followed by a tour of the University of Cincinnati civil engineering facilities, including new hydraulics and soil mechanics laboratories. In the afternoon, the group was transported to Middletown, Ohio, to inspect plants of the Armco Steel Corp., winding up with a banquet as guests of the corporation.

Winners of the student paper contest were Mario Cammarano, of Ohio University, who was awarded first prize for a paper on "The Design of the Camp Rotan Suspension Bridge"; William Zackman, of Case Institute, second prize

Prominent on the program for the Middle Atlantic Conference were Horace A. Reeves, Jr. (far left), president of the Swarthmore Student Chapter and presiding officer; Dwight A. Zink and William B. Wagner (center photo), of Villanova, top winners in the competition for a paper on "An Investigation of Pretensioned and Post-tensioned Concrete Slabs"; and Gordon Smith, of Swarthmore, one of four second-prize winners.

for a paper on "The Effect of Highways and Highway Engineering on the American Way of Life"; and Lawrence Erhardt, of the University of Detroit, third prize for a paper entitled "Do We Want Unionism in Engineering." The Man-Mile Trophy went to Wayne University for the 3,840 man-miles its delegates piled up.

Rocky Mountain Conference

Student paper contests for both graduates and undergraduates were a major feature of the Rocky Mountain Conference held at Utah State Agricultural College at Logan on April 24. Winners in the graduate division were Susumu Karaki, of Colorado A. & M. College, who received first prize of $15 for a paper entitled "Model Study of Seepage from a Canal to a Shallow Water Table," and Andrew Lally, of the University of Colorado, who was awarded second prize of $10 for a paper on "Unionization and Engineers." In the undergraduate contest, the first prize of $15 went to R. L. Berling, of Colorado A & M College, for a paper on "Modern Toll Roads"; second prize of $10 to Leon Christiansen, of Utah State, for a paper entitled "Compressive Strength of Concrete Made with Salt Lake City Fly Ash"; and third prize of $5 to Baryl L. Glasser, of the University of Wyoming, for a paper on "Research on Spent Sulphite Liquor."

The attendance of about 40 included M. J. Shelton, Director for District 11. J. E. Christiansen, dean of the School of Engineering and Technology at Utah State, welcomed the group.

Virginia Conference

The ASCE Chapter at Virginia Polytechnic Institute was host to a well-attended joint conference of Chapters at Virginia Military Institute and the University of Virginia and of the Virginia Section in Blacksburg on April 21. On the agenda were separate business meetings for the participating groups, a luncheon, and inspection trips to the VPI sewage disposal plant and to the $2,000,000 library under construction there. Prof. D. H. Pletta, head of the department of applied mechanics, addressed the joint luncheon on "Training for the Engineering Profession."

Winners in the annual student paper competition were F. W. Barton, of the University of Virginia, who received first prize (ASCE TRANSACTIONS); K. N. Henderson, of VMI, second prize (the manuals of practice); and R. L. Locher, of VPI, third prize (a subscription to CIVIL ENGINEERING).

Some 80 delegates from ASCE Student Chapters in Virginia—Virginia Military Institute, Virginia Polytechnic Institute, and the University of Virginia—are photographed at Blacksburg, Va., during the all-day student conference to which VPI was host. About 35 members of the Virginia Section also took part in the program.

University of Cincinnati men responsible for success of the North Central Conference are (front row, usual order): Donald L. Croll, conference chairman; Emerick S. Gross and Prof. Cornelius Wandmacher, president and Faculty Adviser, U. of C. Chapter; and (back row) G. W. Foster, A. D. Haddad, and L. G Hamlin, conference secretary, vice-chairman, and treasurer.

Student Chapters Honored for Excellence

Award of Certificates of Commendation to fifteen Student Chapters for the meritorious conduct of their affairs during the calendar year 1953 has been made by President Daniel V. Terrell. Since 1935 such certificates have been issued annually upon recommendation of the Committee on Student Chapters following systematic evaluation of each Chapter's overall activities as evidenced in its Annual Report to the Society. Certificates for superior work in 1953 have been issued to Chapters at:

Virginia Military Institute	(18th time)
Carnegie Institute of Technology	(12th time)
Northeastern University	(9th time)
University of Colorado	(8th time)
South Dakota State College	(6th time)
University of Arizona	(5th time)
The Cooper Union	(5th time)
Massachusetts Institute of Technology	(4th time)
Texas Technological College	(4th time)
Georgia Institute of Technology	(3rd time)
University of Alabama	(3rd time)
Missouri School of Mines and Metallurgy	(3rd time)
University of Cincinnati	(2nd time)

University of Maryland (1st time)
University of Notre Dame (1st time)

President Terrell also sent Letters of Honorable Mention to the following 29 chapters whose activities were rated next in merit to the certificate winners:

Bucknell University
California Institute of Technology
University of California
Catholic University of America
Colorado A & M College
University of Dayton
Fenn College
Howard University
State University of Iowa
Kansas State College
University of Kansas
University of Kentucky
University of Louisville
University of Maine
University of New Hampshire
New York University
Newark College of Engineering
Ohio Northern University
Ohio State University
Oregon State College
Purdue University
Rice Institute
Syracuse University
A & M College of Texas
Texas Western College (Branch, University of Texas)
University of Utah
Villanova College
University of Virginia
University of Wyoming

There are currently 134 Student Chapters, two of which have evening as well as day sessions, and four have off-campus branch chapters. For administrative purposes the Chapters are divided into five regions, 27 reporting to each member of the Committee on Student Chapters. In each region, three Certificates of Commendation and up to six Letters of Honorable Mention are available for the annual awards. Total student membership in all Chapters is reported as approximately 9,500.

Engineering Mechanics Division Plans Newsletter

At a recent meeting held in Pittsburgh the Executive Committee of the Engineering Mechanics Division decided to issue a newsletter in the near future and to distribute the Fluid Mechanics Laboratory Aids series, which has appeared in CIVIL ENGINEERING. Douglas McHenry will assume responsibility for supervising the paper and publication work this year, and Clayton Dohrenwend will take over next year.

Plans were also made to streamline the operation of the Division and to broaden the scope of its activities. At the close of the 1954 annual convention Harry Hill, assisted by John McNown, will organize the planning for the 1955 technical sessions. Technical committee chairmen will still carry out the detailed planning for each session as assigned.

The work of the West Coast Engineering Mechanics group, under the chairmanship of Boris Bresler, was commended. Indications point to a successful joint meeting in June with the ASME West Coast Applied Mechanics Committee.

EJC Issues Study of Income of Engineers

Information covering the professional income of about 72,000 engineers employed in industry, government, and engineering education has been made available by Engineers Joint Council in a 32-page publication entitled *Professional Income of Engineers—1953*. The basic presentation of data is in relation to the year of receipt of the first degree in engineering. The income of engineers employed in industry is presented by the type of industry in which the engineer is employed—a departure from the usual practice of presenting data by engineering specialties.

Representing the final report of a survey conducted in 1953 by the EJC Special Surveys Committee, the present publication is said to provide the most comprehensive study of engineering professional income since *The Engineering Profession in Transition*, published in 1947. It is available from Engineers Joint Council, 29 West 39th Street, New York 18, N.Y., at $2 a copy, with a discount of 50 percent for single copies to members of the constituent EJC societies.

Survey Committee Formed By Construction Division

The Construction Division has organized a Survey Committee in an effort to develop facts to prove the significance of the civil engineer in the construction industry, to develop a further source of meeting papers and articles for CIVIL ENGINEERING, and to develop data to assist in the preparation of ASCE manuals. The surveys will be conducted by mail with a forum of 400 to 500 ASCE members qualified to report on the various phases of engineered construction. Heading the Survey Committee as chairman is L. B. Combs, Rear Admiral, CEC, USN (retired), head of the civil engineering department at Rensselaer Polytechnic Institute. Members of the committee are Augustine H. Ayers, George R. Brown, Albert F. Garlinghouse, Joseph F. Jelley, George K. Leonard, Milton Spiegel, Lyman D. Wilbur, and Dwight W. Winkelman.

The first questionnaire has already been mailed. Returns are expected to prove the important position of civil engineers as construction engineering executives and their growing influence in the industry.

Coming Events

Illinois—Weekly luncheon meetings featuring 10-minute speaker at the Chicago Engineers' Club, 314 South Federal St., every Friday, 12 noon.

Los Angeles—Annual field day at the Oakmont Club, Glendale, Calif., June 22, from 12 noon to 10 p.m., will include an afternoon of sporting events, dinner and show. For dinner reservations call Secretary Martin Duke at Bradshaw 2-6161. The Transportation Group will meet for a field tour and dinner at the Los Angeles International Airport, June 23, 6 p.m.

Maine—Meeting of the New Hampshire Branch in Manchester on June 12 will consist of a tour of construction of the toll highway between the Massachusetts border and Concord, N. H.

Sacramento—Weekly luncheon meetings at the Elks Temple every Tuesday at 12 noon.

NOTES FROM THE LOCAL SECTIONS

(Copy for these columns must be received by the tenth of the month preceding date of publication.)

Engineering wonders selected by the **Brazil** Section include several projects built for access to the high plateau of southeastern Brazil: the funicular railroad between Santos and São Paulo which, though over 100 years old, still carries much of the freight between the two cities; the railroad between Curitiba and the coast; and a new four-lane concrete highway between Santos and São Paulo. The other wonders, in the order named, are the world-famous Cubato Power Plant of the São Paulo Light and Power Co.; the tallest building in South America (in São Paulo); the cable car to the top of Sugar Loaf mountain in Rio de Janeiro; and the cog-way up to the statue of Christ on the top of Corcovado in Rio de Janeiro.

The effect of the past two years of drought in Illinois on water supplies was discussed at the March meeting of the **Central Illinois Section** by H. E. Hudson, chief of the Engineering Division of the State Water Survey. Mr. Hudson pointed out that, despite the lack of rain, only 2 percent of the water works in the state are having trouble. Solutions sought by the sixteen towns involved have included hauling water at costs as high as $6.00 per thousand gallons.

Life membership certificates were presented to F. H. Waring and Prof. J. R. Shank at the March meeting of the **Central Ohio Section.** Speaker of the evening was Kenneth Jewell, soils and foundation engineer for the Ohio Turnpike Commission, with a talk on "The Use of Test Fills in Embankment Construction."

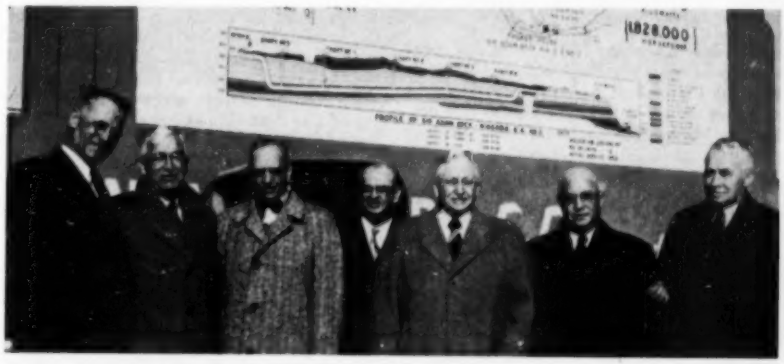
There was gratifying interest in the first program of the **Cincinnati Section's** Sanitary Engineering Workshop, which was called early in April to encourage forward-looking evaluation of water resources. Dealing with the theme, "Industrial Wastes: Managerial and Economic Aspects," the conference allotted two hours to each of the following open forums: (1) Cost Savings by Process Modifications, moderated by John E. Kinney; (2) Combined or Separate Treatment, moderated by Hayse H. Black; (3) Application of Regulatory Measures, moderated by Arthur D. Caster; and (4) Biological and Chemical Opportunities, moderated by Vernon G. MacKenzie. Program chairman was Arthur D. Caster, and the key address was given by B. A. Poole, chairman of the Sanitary Engineering Division. The attendance was 100 for the program and 80 for the luncheon.

Application of photogrammetry to engineering surveys was discussed at the April 9 meeting of the **Cleveland Section** by representatives of several industries in a symposium arranged by Prof. O. W. Mintzer, of Case Institute of Technology. The speed and economy of the use of aerial photography on various projects was underscored by A. R. DeWalt, of the Pennsylvania Railroad; James B. Guthrie, of the Ohio Department of Highways; and C. F. Pearson, of the Cleveland Electric Illuminating Co. Methods and costs were discussed by A. R. Hull, of Aerial Surveys, Inc.

Top men in the senior class at the University of Connecticut—Russel E. Machol and Philip B. Swain, Jr.—received the **Connecticut Section's** annual awards at the April 14 dinner meeting held in Hartford. William B. Tabler, architect for the Hotels Statler, Inc., gave an illustrated talk on the new Hartford Statler.

Labor problems in the Duluth area were discussed at the April 19 meeting of the **Duluth Section** by C. D. Barker, labor relations consultant on construction for Picks, Mather & Co. Colonel Barker also described his experiences as chief of the Labor Division of the Army Corps of Engineers during the war years and for the Manhattan Project from its inception until his retirement from the Army in 1947. The Section's new **Iron Range Subsection** has made its temporary officers permanent for the rest of the year. They are Rodolfo Michels, Jr., president; Melvin C. Tero, vice-president; and Henry B. Schmidt,

Edward L. Murphree, Jr. (left) president of the University of Mississippi Student Chapter, receives Mid-South Section's Award of Merit and a check for $20 from L. A. Tvedt, Student Chapter Contact Member for the Section at the May 5 meeting of Section. The Section's other two 1954 awards went to James W. Yarbrough, of the University of Arkansas, and James L. Garrett, of Mississippi State College.



Officers of Buffalo Section accompany ASCE President Daniel V. Terrell on tour of Sir Adam Beck generating station with the Hydroelectric Power Commission of Ontario as host. Shown here (in usual order) are Gordon Mitchell, project manager for the Power Commission; President Terrell; E. B. Strowger, of the Niagara Mohawk Power Corp.; Joseph E. Tisdel, treasurer of Section; Bernard R. Fuller, vice-president of Section; John R. Campbell, president of Section; and R. L. Hearn, general manager and chief engineer of the Power Commission. The group and a few other members of the Section were also guests of the Niagara Mohawk Power Corp. for an inspection tour of its Niagara Falls developments and a luncheon at the Niagara Falls Country Club.

Photographed with President Terrell at a recent joint meeting of the Mid-Missouri Section and the Missouri School of Mines Student Chapter are (front row) Prof. Leon Hershkowitz, Faculty Adviser; President Terrell; and Coy Brewer, Junior Contact Member for the Section. In back row are V.A.C. Gevecker, assistant dean; James Highfill, vice-president, Missouri School of Mines Student Chapter; James Gerard, president of Chapter; James Jones, secretary of Chapter; Maurice Suhre, Senior Contact Member for the Section; and Prof. E. W. Carlton.

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secretary-treasurer. At its April meeting the Subsection heard Robert Johnson, engineer for the Asphalt Institute, speak on asphaltic road materials.

The difficulties faced by young engineers in breaking into the construction field were discussed by George C. Loorz, president of Stolte, Inc., of Oakland, Calif., at a recent meeting of the **Central Savannah River Valley Subsection** of the **Georgia Section.** Mr. Loorz stressed the need for a higher standard of ethics in the construction business and cited the evils arising from the still prevalent custom of subcontractors cutting their original bids after bids on the general contract have been opened.

The **Intermountain Section** heard papers read by members of the University of Utah Student Chapter at its April meeting in a program to select final contestants for the Rocky Mountain Conference of Student Chapters at Logan on April 24. Taylor Biesinger was pronounced winner by a narrow margin with a paper on "Theory and Design of Prestressed Concrete."

A philosophical presentation of the topic, "What Is Physics," was heard by members of the **Iowa Section** and the Iowa State College Student Chapter at a joint meeting at Ames on April 14. Julian Knipp, professor of physics and member of the staff of the college's Institute of Atomic Research, was the speaker.

Problems facing present-day engineers were discussed by S. C. Hollister, dean of the Cornell University College of Engineering, at the **Ithaca Section's** April meeting. The meeting was a joint session with the Southern Tier section of the ASME.

The **Kansas City Section** is making every effort to get the new Municipal Airport bridge named the Ernest E. Howard Memorial Bridge in honor of its late member, Ernest E. Howard, who was a Past-President of the Society. At the April meeting, ASCE Vice-President G. Brooks Earnest reported actions of the Board at its Atlanta meeting.

Concrete as a building material was discussed at a recent joint meeting of the **Kansas Section** and the Wichita Society of Professional Engineers, on April 23, by C. H. Scholer, professor of applied mechanics at Kansas State College and president of the American Concrete Institute. At another recent Section meeting the speaker was Clare Van Orman, head of the design branch for the Kansas City District of the Corps of Engineers, and the topic, "Flood Control in the Kansas City District."

Establishment of a scholarship program is an important new activity of the **Kentucky Section.** The program, which was endorsed by the Section at its April meeting, will make available a $250 civil engineering scholarship at both the University of Kentucky and the University of Louisville. Annual awards will be made by the Section on the basis of the applicant's scholastic standing, extra-curricular activities, and financial need. The program will be financed by a special committee that is being set up to obtain funds within the Section, with $500 the objective for 1954 and $1,000 per year the goal thereafter. Present Section officers, headed by John H. Clarke, III, as president, have been instrumental in working out the program.

This year the **Los Angeles Section's** annual award to the outstanding senior civil engineering student at the California Institute of Technology is shared by two students—Roland S. Miller and Manuel Morden.

Speakers at recent meetings of the **Maine Section** have been Edwin Webster, of Eaton Tarbell and Associates, who described problems arising in design of the new Bangor Auditorium at a joint meeting of the Bangor Area group with the University of Maine Student Chapter; Victor Kjellman, field engineer for the Portland Cement Association, who discussed present trends in concrete construction at another meeting of the Bangor Area group; and Col. Harry A. Mapes, state director of civil defense, who spoke on the relationship between civil engineering and civil defense at an Augusta Area meeting.

Richard H. Gould, has been named "Engineer of the Year" by the **Metropolitan Section** in its second annual award of this distinction. A former director of the Division of Sewage Disposal of the New York City Department of Public Works, Mr. Gould is cited by the Section "for outstanding creative contributions to the engineering profession in the New York-New Jersey Metropolitan area by his inventive developments in the art of sewage treatment as shown in the progressive construction of treatment works for the entire city of New York." Since his recent retirement from the New York Department of Public Works, Mr. Gould has been associated in New York with the Chicago consulting firm of Greeley and Hansen.

The seven engineering wonders of South Florida, as seen by the **Miami Section,** are the Overseas Highway; the city of Miami Beach; the South Florida Flood Control Project; the International Airport at Miami; the Key West Aqueduct; the Tamiami Trail; and the city of Coral Gables.

Junior Members of the **Mohawk-Hudson Section** arranged the program for the April meeting, which was held at Union College, Schenectady. Speaker of the evening was Charles F. Green, consulting engineer in charge of advanced development for the Aeronautics and Ordnance Systems Division of General Electric, who outlined the development and uses of rockets from the V-1 and V-2 rockets of World War II to present-day accomplishments in guided missiles. Dr. Green is a member of the Upper Atmosphere Panel, which directs the nation's

Roy Gaul, of **Texas A & M College** (left, above) receives $25 and certificate for winning first place in the **Texas Conference** of Chapters from President Terrell during the **Texas Section's** recent spring meeting at Midland, Tex. Second place winner was Edwin S. Wright, of Southern Methodist University, who received a certificate and $15. During the program President Terrell presented life membership certificates to (left to right, top photo) Robert Olen Jameson, Lee Harvey Huntley, and Willard Eastman Simpson. The separate technical sessions held in the fields of Soil Mechanics and Foundations, Water Resources, Pipeline Construction, and Sanitary Engineering were very well attended.

upper atmosphere rocket research program in behalf of the armed forces, education and industry.

A panel of **Mid-South Section** members has selected the seven engineering wonders in the area. In the order named the wonders are: (1) the Lower Mississippi River control system of levees, bank stabilization, and channel cutoffs; (2) the Yazoo River Headwater Reservoir System in Mississippi, corollary and supplemental to the Lower Mississippi Control System; (3) the Memphis and Arkansas Bridge over the Mississippi at Memphis; (4) Bull Shoals Dam and Reservoir project in northern Arkansas; (5) the Coliseum Building on the Arkansas Livestock Show grounds at Little Rock; (6) the Delta Steam Station of the Mississippi Power & Light Co., at Cleveland, Miss.; and (7) the new aluminum plant of the Reynolds Metals Co., at Gum Springs, Ark.

Exceptional student papers were given at the **New Mexico Section's** annual spring meeting held at State College and Las Cruces on April 23 and 24. Winners in the annual student contest were Dayle Clark, of Texas Technological College, who received the first prize of $25 for a paper on prestressed concrete; Ed Martch, of Texas Western College (a branch of the University of Texas), who was awarded the second prize of $15 for a paper on the design of barge-type foundations; and John White, of New Mexico A & M, who received third prize of $10 for a paper on alignment of railroad curves during maintenance operations. Another highlight of the two-day program was a visit to the new Las Cruces municipal sewage-disposal plant.

The **Philadelphia Section** has picked as the Seven Engineering Wonders of the Delaware Valley: the Fairless Plant of the U. S. Steel Corp., at Morrisville, Pa.; the Delaware Memorial Bridge; the Pennsylvania-New Jersey Turnpike Systems; New York City's Delaware Water Project; Philadelphia Electric Co. power plants; the Schuylkill River dredging project; and oil refineries in the Delaware River Estuary. The Delaware Valley is the theme of the Society's forthcoming June Convention, to which the Philadelphia Section is host.

Highway planning for metropolitan Providence was discussed at the April meeting of the **Providence Section** by a panel consisting of D. S. Hammond, of Charles A. Maguire & Associates; John T. Howard, of Adams, Howard & Greeley; William B. Knowles, of the United Transit Co.; and Edward F. Judge, past-president of the Providence Real Estate Board.

A panel discussion on Portland's Bridge Problem, with special attention to the proposed Morrison Street Bridge, made up the program for the April 15 meeting of the **Oregon Section.** The experts were P. C. Northrup, assistant Multnomah County roadmaster; Lloyd T. Keefe, director of the Portland City Planning Commission; Fred T. Fowler, Portland traffic engineer; and Glen S. Paxson, assistant state highway engineer.

Winners of the **Spokane Section's** annual prizes of Junior Membership in the Society are Gary Stoor, of the University of Idaho, and Doyle Brown, of Washington State College. The awards were presented at a recent joint meeting with the Student Chapters at the two institutions. William A. Bugge, state highway director, was featured speaker, with a talk on "Highways and Vehicles."

There was a good turnout of **Syracuse Section** and Syracuse University Student Chapter members for a recent meeting in honor of President Terrell. Dean Terrell was after-dinner speaker with a talk on Society affairs.

Attending a recent joint meeting of the West Virginia Section and West Virginia University Student Chapter is this contingent of Student Chapter members. The joint session was addressed by Martin A. Mason, dean of the School of Engineering at George Washington University and member of the ASCE Committee on Research. Dean Mason's subject was "Developments in Engineering Research."

Scheduled ASCE Conventions

ATLANTIC CITY CONVENTION
Atlantic City, N.J.
Chalfonte-Haddon Hall
June 14-19, 1954

NEW YORK CONVENTION
New York, N.Y.
Hotel Statler
October 18-22
1954

SAN DIEGO CONVENTION
San Diego, Calif.
Hotel U. S. Grant
February 6-11, 1955

Gurley current meters now available in fresh or salt water models

Gurley, maker of fine current meters for federal, state and municipal bureaus for 70 years, now supplies its Price Pattern Current Meter in either fresh or salt water models. Gurley's Price Pattern instruments, designed by W. G. Price of the U. S. Geological Survey, are in use around the world.

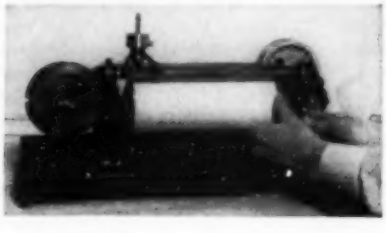
The Gurley Current Meters are available in a variety of outfits for use by overhead-cable suspension...wading-rod suspension...exploration and survey parties. Gurley also makes the Pygmy for shallow streams, flumes and canals.

The salt water model incorporates a commutator which indicates each tenth revolution of the bucket wheel. Sealed commutator box excludes salt water, a conductor of electricity, from the contact chamber. *Write for Bulletin 700.* This illustrated 16-page booklet gives full details on all Gurley Current Meter outfits.

Gurley Water Level Recorders make continuous graphic record for entire day or week.

The float-operated Gurley Graphic Water Level Recorder, simple in construction and operation, is widely used in reservoirs, sewers, sewage disposal and hydro-electric plants, and supplements irrigation and stream gaging measurements.

Made of non-corrosive materials, Gurley Recorders make a *continuous* graphic record. A rectangular chart is used. Available in natural scale models or others adaptable from 1 to 40 feet. *Write for details.*



GURLEY

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The **San Diego Section** has passed a resolution endorsing a proposed bond issue to construct sewage treatment facilities for the city as proposed in the 1952 report of the Board of Engineers. This action was taken at the May 5 meeting, at which ASCE President Daniel V. Terrell spoke on the general objectives of the Society and the need for a dues increase. In another featured talk Dr. Claude Zobell, professor of microbiology at Scripps Institute of Oceanography, described the "Round the World Danish *Galethea* Deep Sea Expedition." Dr. Zobell was the only American scientist invited to take part in the expedition, which studied animal life on the ocean bottom.

Cloud seeding to increase moisture may become standard practice in parts of the world where there is insufficient rainfall, Loren W. Crow, assistant to the president of Water Resources Development Corp., told members of the **Fort Worth Branch** of the **Texas Section** in the featured talk at their April 12 luncheon meeting. Mr. Crow said that such practices will be found to "cost less than some of the plans now being considered for diverting water from streams and reservoirs to arid regions a great distance from them." He emphasized that there must be some degree of natural precipitation for cloud-seeding to do any good.

ASCE MEMBERSHIP AS OF MAY 10, 1954

Members	8,572
Associate Members	11,035
Junior Members	17,606
Affiliates	70
Honorary Members	42
Total	37,325
(May 8, 1953	36,147)

At a recent joint meeting of the **Toledo Section** and the Student Chapters at Toledo and Ohio Northern universities Bill Blaisdell, sales representative for the Vermiculite Institute, spoke on Vermiculite as a construction material.

The prestressed concrete bridges of the Caracas-La Guaira Superhighway have been voted the most outstanding project in the **Venezuelan Section.** Nominated as another engineering wonder is the huge University City project being built in Caracas.

Austin Branch to Be Host to Hydraulics Division Meeting, Austin, Tex., September 8–10

Further details of the forthcoming meeting of the Hydraulics Division, to which the Austin Branch of the Texas Section will be host September 8, 9, and 10, are announced by Albert S. Fry, Division chairman. Headquarters for the meeting will be the Hotel Driskill, which will have air-conditioned rooms for both the meetings and those in attendance. The Housing Committee, under the chairmanship of Ben Ewing, will soon have available a list of hotels, motels, and tourist courts, together with prices and a description of these accommodations.

An excellent technical program is in the making, with sessions already arranged on ground water, hydraulics, meteorological phases of flood studies, maintenance and operation of flood-control works, and sedimentation. The complete program will be published in the August issue. ASCE Director Raymond F. Dawson is in charge of technical program assistance.

Austin, capital city of the state, offers sightseeing opportunities galore. The capitol, which reaches a height of 311 ft and covers 18 acres of flood space, is second in size only to the national Capitol in Washington. The University of Texas in downtown Austin has a beautiful 40-acre campus and a museum of fascinating historical displays. Many varied attractions will be available to convention visitors in neighboring regions as well as in Austin. These include the Highland Lakes on the upper Colorado River (which offer superb boating and fishing and to which a trip is planned); the Alamo in San Antonio; the San Jacintos Battlefield near Houston; extensive ranchlands; the Mexican border towns; the tremendous industries of the area; and Gulf Coast swimming and deep sea fishing.

For those wishing to include a trip to Mexico in their itinerary, the National Railways of Mexico has arranged a nine-day post-convention tour with departure at 10:35 a.m. Saturday, September 11, from the Missouri Pacific station in Austin, and arrival in Mexico City at 8:00 p.m. Sunday. Headquarters will be a first-class hotel. From Monday morning on there will be sightseeing trips in Mexico City, to the Pyramids, Xochimilco, Cuernavaca, Tasco, Puebla, Cholula, and the volcanoes Popocatepetl and Iztaccihuatl. The return trip will depart from Mexico City at 8:20 a.m., Saturday, September 18, and arrive in San Antonio at 1:30 p.m. Sunday. Costs per person from Austin to Mexico City and return to San Antonio vary from $125 to $170, depending on the type of accommodations. These costs include rail transportation, pullman, hotel, meals, and sightseeing, but do not include meals on train or personal expenses. Persons interested should write to F. Alatorre, General Agent, National Railways of Mexico, 2401 Transit Tower, San Antonio, Tex.

Robert L. Lowry is general chairman for the meeting.

Robert Lowry, general chairman for Hydraulics Division meeting (seated second from left), discusses program plans with some of his committee chairmen. Seated, in usual order, are Walter Moore, president, Austin Branch; Mr. Lowry; Mrs. Trigg Twichell, chairman, Ladies' Program; John Montgomery, vice-chairman for meeting and chairman of publicity; and ASCE Director Raymond Dawson, chairman, Technical Program. In back row are John Focht, chairman, Registration and Finance; Ben Ewing, chairman, Housing Committee; W. D. Ramey, secretary, Austin Branch; Randall Alexander, president, Texas Section; Obie Ethridge, vice-president, Austin Branch; and Trigg Twichell, chairman, Entertainment Committee.

FROM THE NATION'S CAPITAL

JOSEPH H. EHLERS, M. ASCE — Field Representative ASCE

Legislative Review

Legislation which will have an important impact on engineering and construction has been enacted during the past few weeks.

The St. Lawrence Seaway (P.L. 358, signed May 13) was authorized by substantial majorities in Congress. A St. Lawrence Seaway Development Corporation will issue bonds to a limit of $105 million outstanding at any time, to construct in cooperation with Canada a 27-ft-deep navigation channel with canals and locks. Enactment of this legislation climaxes half a century of effort that gained in momentum with the agricultural and industrial development of the Great Lakes area. East Coast seaport states, railways, and inland water carriers have been among the leading opponents. It is quite likely that the project will not have the adverse results predicted by its opponents and that by the time it gets into operation the normal growth of the nation will have absorbed any shock that might have been expected in any area.

The Federal-Aid Highway Act of 1954 (P.L. 350, signed May 6) authorizes $966 million a year for continuing the construction of highways in fiscal 1956 and 1957. By far the largest boost is for the specially designated interstate system. In addition to the federal-aid work, $81 million is authorized for roads and $10 million for Latin American work. Further details on the bill were given in this column in the May issue.

Signing of P.L. 356 climaxed two years of effort, spearheaded by the Associated General Contractors, to secure judicial review of decisions of federal officers under the disputes clause of government contracts. The American Bar Association and ASCE also presented arguments in support of the bill to the congressional committees. The law offsets the effect of the Supreme Court decision in the "Wunderlich Case" and part of the decision in a previous case known as the "Moorman Case," which permitted an agency decision to be considered final even in a dispute over a point of law.

The Supreme Court itself had in these decisions simply interpreted an existing contract provision and suggested that Congress could readily change the situation if a different interpretation was desired. Under the new law the decision of an agency can be set aside, even in the absence of fraud, if it is found to be "capricious or arbitrary or so grossly erroneous as necessarily to imply bad faith, or is not supported by substantial evidence." The full effects are not yet apparent but some revision will probably be made in the procedure of agency boards now reviewing decisions of contracting officers. Although the case arose in connection with a construction contract, the law is applicable to other contracts, including those for professional services. One possible effect may be to increase the influence of the Comptroller General in these disputes.

P.L. 313, recently signed, improves the relative position of sanitary engineering officers in the Army Medical Service.

Public Law 325 provides for the establishment of a United States Air Force Academy. Considerable architectural and engineering work will be involved. Interested parties may communicate with Air Force Academy Project, Headquarters USAF, Washington, which is under the Assistant Chief of Staff for Installations.

Public Law 363, increases the fund authorization for the Columbia River projects from $150 to $166 million.

Pending Legislation

The general tax-revision bill, H.R. 8300, has passed the House and is under consideration in the Senate. The House version contains several provisions specifically affecting engineering and construction. Provisions for accelerated depreciation are of interest to contracting and engineering firms and to building owners. Income received by corporations for construction and technical engineering services abroad could be deducted from taxable income up to 14%. Likewise there would be a personal income-tax exemption on earnings of engineers and others actually residing abroad for 17 out of 18 months, up to a limit of $20,000 for the taxable year involved. This bill was supported by ASCE before the congressional committee.

The bill to extend the Renegotiation Act of 1949, already passed by the House, is up for debate in the Senate. As reported out by the Senate Committee, the bill contains an amendment to raise the lower limit for renegotiating from $250,000 to $500,000. ASCE supported this amendment in the Senate Committee.

The bill to require the separate letting of mechanical and other specialty contracts on government construction will receive no further consideration in this session of Congress. It is unlikely that any revision of the Taft-Hartley Act affecting engineers will be considered this year.

The bill providing for development of the upper Colorado River and including the controversial Echo Park Dam has been approved by a House Interior Department subcommittee. Total cost would approach $1 billion.

Meetings and Conferences

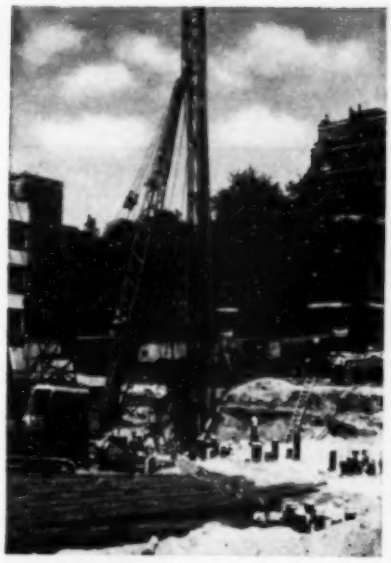
During the past month meetings of interest to engineers and others involved in construction have been held.

Maj. Gen. J. S. Bragdon, recently appointed coordinator of construction on the staff of the Council of Economic Advisers, talked to a group of professional and trade association executives in the public works field on various aspects of the use of public works as an anti-recession measure. The meeting was held under the auspices of the Washington staff of ASCE and AIA. General Bragdon's assignment to this work for the Council has brought added interest to the subject of federally aided public works planning and construction. The housing bill approved by the House authorizes $10 million for "advances" to local bodies for preliminary planning of local public works.

Present problems and future plans relating to highway development were discussed at a recent National Highway Transportation Congress. Uniform laws and standards were pointed to as great aids in this field. Highway financing was again viewed as the greatest obstacle to the solution of the roads problem.

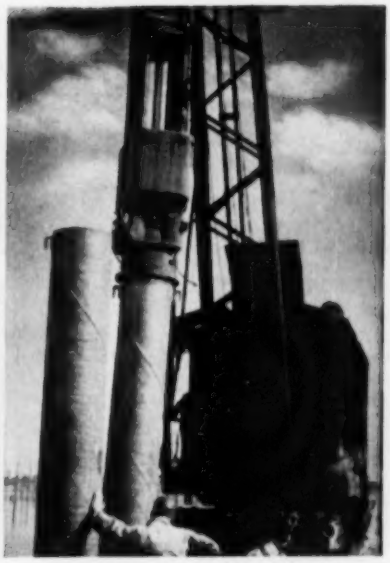
The President's Conference on Industrial Safety considered some problems in the construction field during its three-day session.

Washington, D.C.
May 15, 1954



Driving Armco Pipe Piles for foundation of Chicago apartment building.

Armco Caissons are being used here in rebuilding old railway bridge.



These Armco HEL-COR Pile Shells will support new superhighway bridge.

Which foundation pipe will handle your job?

Few foundation pipe jobs are alike. But with Armco Pipe Piles, Caissons and Pile Shells to choose from—you'll find it easy to match almost any requirement.

ARMCO PIPE PILES AND CAISSONS are both of welded spiral seam fabrication. They offer high collapse resistance, unusually great beam strength, constant cross-section, and uniform diameter that permits salvaging cutoffs. Pipe piles are supplied with mill-attached plate ends, cone points or cutting shoes. Special cast or fabricated steel shoes can be mill-attached to caissons for open-end driving.

ARMCO HEL-COR PILE SHELLS have helical corrugations and a continuous lock-seam. They are easily handled, light in weight, extremely straight, uniform in diameter and watertight. Cutoffs can be salvaged. Widely used for Cobi mandrel-driven or drop-in shells for the top portion of composite piles.

For specific data on your foundation problems, write us. Armco Drainage & Metal Products, Inc., Welded Pipe Sales Division, 3924 Curtis Street, Middletown, Ohio. Subsidiary of Armco Steel Corporation. In Canada: write Guelph, Ontario. Export: The Armco Steel International Corporation.

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DESIGN	PRODUCT NAME	DIAMETER O. D.	WALL THICKNESS	LENGTHS
	ARMCO PIPE PILES	8⅝" to 22"	.141" to .500"	Up to 93 feet
	ARMCO CAISSONS	24" to 36"	.375" to .500"	Up to 70 feet
	ARMCO HEL-COR PILE SHELLS	8⅝" to 22⅛"	18 to 14 Gage	Up to 60 feet

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ARMCO FOUNDATION PIPE

NEWS BRIEFS . . .

U.S. Firms Receive Large Australian Dam Contract

Award of a $60,000,000 construction contract for a dam and mammoth water tunnel through the Snowy Mountains of Southeast Australia to the Kaiser-Walsh-Perini-Raymond group of United States contractors is announced by the National Development Minister of the Australian Government. Designed by the U. S. Bureau of Reclamation under an agreement between the Commonwealth of Australia and the U. S. Department of State, the project calls for impounding the waters of the Snowy River and its main tributaries and diverting them through long tunnels under the dividing mountain range for irrigation and production of power. Ultimately the development will make available nearly 2,000,000 acre-ft of irrigation water annually, and provide some 3,000,000 kw of power—an amount exceeding the total capacity of all generating stations currently in operation in the country.

The Snowy-Tutmut development (October 1950 issue, page 52) is one of the largest water projects in the world. It will include the construction of seven major dams, over 80 miles of large-diameter tunnel, 17 power stations, more than 400 miles of aqueducts, and a number of subsidiary works.

The contract just awarded covers the construction of a 26-ft-dia diversion tunnel 14 miles long, a 100-ft-high, diversion structure, and a concrete arch dam 290 ft high.

The joint-venture group consists of the Kaiser Engineers Division of the Henry J. Kaiser Co. as sponsor; the Walsh Construction Co., Raymond Concrete Pile Co., and Arthur A. Johnson Corp., New York; B. Perini & Sons, Inc., Framingham, Mass.; General Construction Co., Seattle; and the Bates & Rogers Construction Corp., Chicago.

Canadian Construction Company Established

The Power Corporation of Canada, Ltd., and F. H. McGraw & Co., engineers and constructors of Hartford (Conn.) and New York City, announce the incorporation of a new Canadian engineering and construction firm to be known as F. H. McGraw Company of Canada, Ltd., with headquarters in Montreal. The new company will seek engineering and construction contracts in Canada's rapidly expanding industrial building field.

Clifford S. Strike, M. ASCE, president and treasurer of F. H. McGraw & Co., will also be president of the new company, and R. J. Sharpe, of Montreal, will be vice-president and general manager. The McGraw company's major current project is the $650 million gaseous diffusion plant for the Atomic Energy Commission at Paducah, Ky., which is now nearing completion.

Electrical Engineers Name N. S. Hibshman Secretary

Appointment of Nelson S. Hibshman, of Brooklyn, N. Y., as secretary of the American Institute of Electrical Engineers, is announced by Elgin B. Robertson, president of the AIEE. Mr. Hibshman, who has been assistant secretary since January 1, 1953, was named secretary at a recent meeting of the board of directors in Chicago. He succeeds H. H. Henline, of Scarsdale, N. Y., who has retired after holding the post of secretary since 1932.

N. S. Hibshman

A former educator and dean of engineering at Pratt Institute of Technology, Brooklyn, Mr. Hibshman has been a member of the AIEE since 1927. He took office as secretary on May 1.

USGS Observes Its 75th Anniversary

Public service in a tradition of unbiased fact finding was the theme of a special program held in Washington, D.C., on April 21 to mark the 75th anniversary of the founding of the U.S. Geological Survey. Dr. William E. Wrather, director of the Survey, gave the keynote address at the celebration, which was attended by top government officials and leading scientists. In reviewing the organization's 75-year history, Dr. Wrather noted that while its work is seldom of a spectacular nature, "The Survey through the years has consistently chosen to remain an unbiased fact-finding and professional agency, assembling and dispensing information that can be used by the engineering profession in planning, design, and construction."

The principal operating programs of the agency were discussed by Wilmot H. Bradley, chief geologist; Harold J. Duncan, chief of the Conservation Division; Carl G. Paulsen, M. ASCE, chief hydraulic engineer; Gerald FitzGerald, chief topographic engineer; and Rcbert L. Moravetz, chief of the Publications Office.

The anniversary program was sponsored by the Washington Society of Engineers in cooperation with the District of Columbia Council of Engineering and Architectural Societies.

Huge Sheaves Placed in Welfare Island Bridge

The last pair of sheaves for supporting the vertical lift span of the $6,500,000 bridge to New York's Welfare Island is hoisted into place in the 170-ft-high tower on the Queens side of the structure. The sheaves, which were fabricated of rolled plate and forgings at the Bethlehem, Pa., plant of the Bethlehem Steel Co., are about 15 ft in dia and weigh 37 tons apiece—the largest welded-type sheaves ever made. They were hoisted into place by means of a derrick on falsework by the Harris Structural Steel Co., which is doing the erection job. The three-lane bridge, spanning the east channel of the river, will afford speedier access to Welfare Island. At present automobiles can reach the island only by elevator from the traffic-congested Queensboro Bridge. Knappen-Tippetts-Abbett-McCarthy is the engineering firm.

Armco Steel Acquires Southwest Steel Products

To develop and expand the bar joist business in the southwestern part of the country, the Armco Steel Corp., Middletown, Ohio, has acquired all the common stock of Southwest Steel Products, a steel fabricating company located in Houston, Tex. Principal products of Southwest Steel Products are fabricated reinforcing bars, bar joists, roof decking, and other construction products.

New Texas Aluminum Works Starts Operation

Formal dedication of the Aluminum Company of America's new four-potline works at Rockdale, Tex., took place on April 24, in ceremonies attended by Texas Governor Allan Shivers and industrial and business leaders of the state. The Rockdale Works, which adds 90,000 tons annually to the nation's expanding aluminum-smelting capacity, is the first such plant in history to use lignite as fuel for generating the tremendous amounts of electric power required in the production of aluminum.

The feasibility of using processed Texas lignite as fuel for large-scale generation of electricity was first brought to ALCOA's attention by the Texas Power & Light Co., which has been sponsoring studies in the fuel technology of lignite in cooperation with the U.S. Bureau of Mines laboratories at Denver, Colo. Power for Rockdale operations is being provided by the Sandow Power Plant, which is owned by ALCOA and operated for it by the Industrial Generating Co., an affiliate of the Texas Power & Light Co.

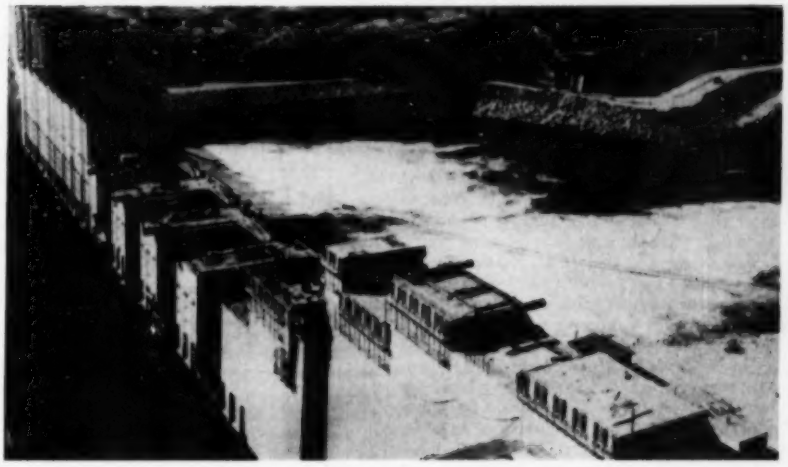
Operation of the Rockdale Works brings the total annual capacity of aluminum-producing plants in the state to about 260,000 tons—approximately one-sixth of the nation's total. Texas now ranks second among aluminum-producing states in the country.

Moles Elect New Officers

George F. Ferris, M. ASCE, president of the Raymond Concrete Pile Co., was elected president of the Moles, New York society of heavy construction men, at the annual meeting of the organization on May 5. Mr. Ferris served the society as vice-president for 1953–1954. As president he will succeed Richard E. Dougherty, Past-President of ASCE and consultant with the New York firm of Seelye, Stevenson, Value and Knecht.

Other new officers elected were A. Holmes Crimmins, of the Thomas Crimmins Contracting Co., first vice-president; Thomas J. Walsh, Jr., of the Walsh Construction Co., second vice-president; and James B. Martin, M. ASCE, of the General Contractors Association, sergeant-at-arms. Harry T. Immerman, M. ASCE, of Spencer, White & Prentis, and Edward G. Johnson, of the Arthur A. Johnson Corp., were reelected secretary and treasurer, respectively.

Steel Forms Speed Concreting on Chief Joseph Dam



Advancing role of steel forms in large concreting operations is illustrated in Chief Joseph Dam on the Columbia River (shown here), where Blaw-Knox cantilever forms are being used on dam and powerhouse. In this structure first major use of such forms for the powerhouse draft tubes is also being made. The 20 curved draft tubes were shaped around one set of four-section, wood lagged steel forms, eliminating the need for much carpentry. The draft tube steel form is built in sections to permit easy handling. A Corps of Engineers project, the $190,000,000 installation will have the world's longest single powerhouse (2,036 ft), and its capacity of 1,728,000 kw will be exceeded only by Grand Coulee's two powerhouses. Electric energy from Chief Joseph Dam will go into the Pacific Northwest Power Pool and be used by many industries, including aluminum processing and the Hanford operations of the Atomic Energy Commission. It will be in operation late in 1955.

N.Y. Concrete Industry Board Acts to Improve Concrete

In an effort to raise the quality of concrete in the New York area, the action committee of the city's Concrete Industry Board has come up with eight recommendations. Taking cognizance of the fact that all phases of concrete production must be controlled, the recommendations include such steps as evaluation of portland and natural cements in the area, certification of testing laboratories, and a highly controversial recommendation for certification of concrete inspectors and contractors' superintendents.

The recommendations, as made by the committee, are as follows:

1. Certification of all testing laboratories concerned with concrete as to adequacy of facilities and personnel. Facilities of the Cement Reference Laboratory of the U.S. Bureau of Standards or other recognized agency should be given consideration in carrying out the certification program.

2. Establishment of standards for facilities and personnel of ready-mix plants with a view toward certification of concrete by the producers.

3. Establishment of a code of ethics for the concrete industry, to which all members of the CIB must subscribe. We recommend further that work should start immediately on a code of ethics for contractors.

4. Steps should be taken to amend the city building code by eliminating "average" concrete for use in reinforced concrete and requiring all reinforced concrete to be "controlled" concrete under the supervision of the architect or engineer who designed the structure.

5. Members should be kept informed of changes and proposed changes in the city building code.

6. Establishment of a committee to handle grievances and complaints in connection with violations of codes of ethics, certifications, and performance.

7. Study should be made of certification of concrete inspectors and contractors' superintendents.

8. Evaluation of properties of portland and natural cements used in the New York area.

The committee has been authorized to take action to implement its recommendations, and appropriate committees are being formed to handle each item. Members of the committee are Elliott Haller (chairman), William Eipel, Elliott Harris, John J. Hogan, A.M. ASCE, and Frederick S. Merritt, M. ASCE.

April Construction Activity at Peak for the Month

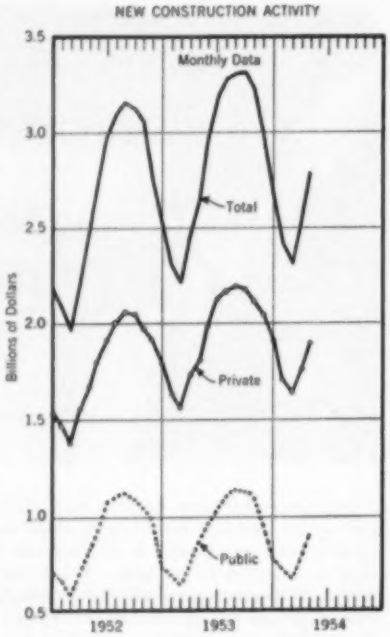
Construction activity continued at record levels in April, with total dollar outlays for new work rising 9 percent from March to $2.8 billion, according to preliminary estimates of the Building Materials and Construction Division of the U.S. Department of Commerce and the Department of Labor's Bureau of Labor Statistics. The gain for the month was about usual for the time of year, and brought expenditures in 1954 to more than $10 billion, or slightly above the 1953 figure for the first four months.

According to the joint agencies, the March-April rise mainly reflected the usual spring expansion in private residential construction, plus a more-than seasonal spurt in highway activity. Total private expenditures increased by 7 percent from March to $1.9 billion in April, and public outlays rose by 16 percent to $900 million. Spending was at peak rates for the month of April on highways; commercial, religious and educational (private and public) building; and public-utility sewer and water construction.

Private residential building, totaling $956 million in April, was up 10 percent from March and at about the same level as in April 1953. Commercial building failed to rise seasonally during the month, reflecting a decline in contract-award values during the past winter. However, the April 1954 level was one-third greater than a year ago, and recently advancing award rates indicate that spending for new commercial structures will rise in May. Private industrial construction, which usually manifests a downward drift in the early part of the year, continued in April to show the less-than-seasonal decline that has been evident since January. Most types of public construction showed a strong uptrend in April.

During the first four months of 1954, private expenditures for new construction totaled more than $7 billion—about 3 percent above last year's volume for the same period. Among major types of private work the only declines were in farm and industrial construction. Although the dollar volume of private residential and hospital building was only slightly above a year ago, most types of private nonresidential building (stores, offices, schools, and churches) were at peak levels well above the January-April totals in previous years.

Public construction in the first third of 1954 totaled $3.1 billion, slightly less than in the same period of 1953. A substantial decline in expenditures for military facilities and public housing, plus declining outlays for public industrial and hospital building, slightly more than offset large increases on school building, highways, and sewer and water construction.



Rise of total construction outlays for April to $2.8 billion, an increase of 9 percent from March and a new peak for the month, is indicated in Commerce Department curves.

Arabian Engineers Hold Fifth Conference

The primary role of the engineer in building up the Arabian countries was stressed at the recent Fifth Arabian Engineering Congress held in Cairo, Egypt. Indicative of the importance of engineers and architects in the economic and political development of the area is the fact that a number of engineers have held ministerial posts in the Egyptian government.

In each of the Arabian countries there is a National Committee for the conferences, with delegates from these committees constituting a Permanent Committee of the Conferences. General secretary of the Permanent Committee of the Conferences is El Said Gawdat, engineer and former vice-minister in the Egyptian government.

The present conference, which was conducted by the Egyptian National Committee, was the largest and most successful ever held in the Middle East. Egyptian engineers contributed the greater number of the 78 papers presented, though Syria, Lebanon, and Tunisia were also represented on the four-day program. Among the topics studied were industrial and agricultural production development, building legislation and town planning, soil mechanics, and the engineer's and architect's responsibility.

Nashaat Morsy, architect and owner of a technical monthly called *Al Khoubara Review*, forwarded a report of the congress to CIVIL ENGINEERING.

U.S. Firm to Build Large Venezuela Power Plant

The Kuljian Corp., engineers and constructors with headquarters in Philadelphia, will design and construct the building for the first two units of a $45,000,000 power plant in Caracas, Venezuela, to be built by the C. A. La Electricidad de Caracas, the country's leading utility company. To be called "Planta Tacoa," the new generating plant eventually will double the existing power potential of Caracas. Initial plans call for a building to house two 40,000-kw generating units. Four 60,000-kw units will be added later, giving the station an ultimate generating capacity of 320,000 kw. The main stair tower and elevator serving the enclosed portions of the plant, and service platforms around the huge semi-outdoor steam boilers are special features of the Kuljian design.

The project will be situated just west of La Guaira, between a series of reefs, the remains of a former coastline, and the tip of the Arrecifes peninsula—a site entirely covered with water. To reclaim the site, engineers have built a large sea wall on the northern boundary. The reefs, acting as a wavebreak, helped reduce the cost of the wall, and fill was provided by local weathered rock.

Modernization of Brooklyn Bridge Completed

Following a four-year, $7,000,000 overhaul job, the 71-year-old Brooklyn Bridge was restored to full use on May 3 in ceremonies conducted by Mayor Wagner and other city officials. Praising the work of those who took part in the modernization of the structure without impairing its original beauty, Mayor Wagner noted that the restoration has effected a valuable increase in vehicular capacity. The bridge now has three 10-ft-wide lanes on each side of a central pedestrian promenade instead of the original four. A lane for street cars and one for elevated trains have been eliminated. Estimated daily capacity is now 50,000 cars in comparison with the 1949 daily capacity of 37,244.

Frederick H. Zurmuhlen, M. ASCE, Commissioner of Public Works and host for the opening ceremonies, called the bridge "a monument to engineering genius and human aspiration and development" and a symbol of the devotion of the Roeblings. Replacement of the bridge's wooden blocks and cobblestones with steel grid and concrete paving, he said, has increased its weight to such an extent that heavy vehicles such as trucks and buses, must be kept from using the structure except in emergency.

D. B. Steinman, M. ASCE, was consultant in charge of plans for redesign of the structure. The Department of Public Works supervised construction of the project.

Sharp Rise in World Water Power Reported

Since 1920 there has been a phenomenal increase in the development of water power all over the world as well as in the United States, according to the U. S. Geological Survey, which has just completed a study of both developed and potential power. Released as Circular 329, the findings show that the development of water power for the world as a whole increased 500 percent during the period, while the increase for the United States was slightly over 400 percent. The fact that water-power development was greater in the United States prior to 1920 than in other parts of the world accounts for the different rate of increase. Development in all countries is continuing at an unprecedented rate.

Water-power capacity now in process of installation will total more than 4,000,000 hp in the United States in the next few years, more than 3,000,000 hp in Canada, and more than 1,000,000 hp in Australia. The Union of Soviet Socialist Republics is said to have plants under construction that will produce 6,000,000 hp.

Africa was found to have the greatest potential power and the smallest installed capacity of the continents. However, actual development of much of the power presents almost insurmountable obstacles owing to inaccessibility and remoteness from possible points of use. Much of Asia's potential power is on large northern rivers, also remote from possible markets.

Free copies of the report, prepared by Benjamin E. Jones, M. ASCE, and Lloyd L. Young, may be obtained from the Director of the U. S. Geological Survey, Washington 25, D.C.

Contract Given for New Ford Building

The Ford Motor Co. has awarded a general contract for construction of its new twelve-story administrative building at Dearborn, Mich., to the Bryant & Detwiler Co., of Detroit. Site preparation and foundation work have been under way since last fall. The present contract will cover all remaining work except installation of movable interior partitions, a feature that will allow flexible floor arrangements.

Bryant & Detwiler have a previous contract for excavation and the concrete foundation. Other contracts are held by the Raymond Concrete Pile Co. for piling; the Bethlehem Steel Co. for structural steel; and the H. H. Robertson Co. for sub-floors. Skidmore, Owings, and Merrill are the architect-engineer.

Eleven-Stage Compressor to Create 2,000-mph Winds

Parts for what is believed to be the world's largest rotating object, an eleven-stage axial-flow compressor, were recently completed by the Newport News Shipbuilding and Dry Dock Co. and loaded on a cargo ship for the first leg of a long trip to the Ames (Calif.) Aeronautical Laboratory of the National Advisory Committee for Aeronautics at Moffett Field, Calif. The compressor, which weighs 2,600,000 lb and costs over $2,000,000, will be installed in the new 8-ft supersonic wind tunnel at Ames, one of the fastest high-speed facilities in the United States. The huge tunnel will provide three new high-speed research facilities—one in the transonic range and two covering supersonic ranges.

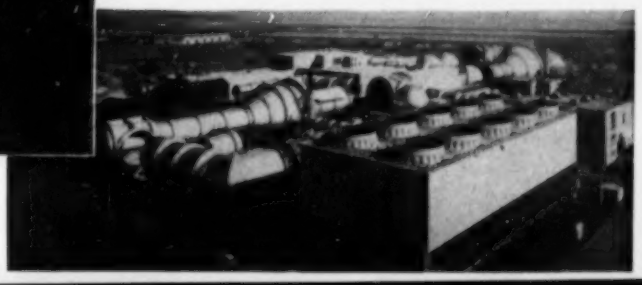
The massive compressor will service two tunnel loops with the use of 24- and 20-ft flow diversion valves, which were also built at Newport News. Operating on a single shaft, the compressor will be capable of producing winds of more than 2,000 mph, more than three times the speed of sound. As an example of its tremendous capacity, it could empty the air in a building the size of the Radio City Music Hall in about a minute. Four General Electric motors with a total capacity of 216,000 hp will be coupled to a single shaft to turn the compressor and achieve the airstream velocities required. Each will weigh about 145 tons.

The rotating portion of the compressor is composed of eleven large rotor discs with machined slots on their rims for attachment of blades. With shafting and spacers, they will weigh over 400 tons. The 96,000-lb discs were the largest-diameter forgings ever produced by the Bethlehem Steel Co., and their cost was in excess of $50,000 each. Almost half the 48-ton weight was removed in the machining, slotting, and drilling operations at the Newport News Shipbuilding plant. The stage wheels with blades attached will have a diameter of 22 ft, almost the height of a two-story building. Nine precision operations are involved in their fabrication. The 86 to 110 slots on each wheel, in which the blades will fit, were machined to within .005 in. on special milling heads designed and built in the Newport News plant. The 50,000-lb finished wheels were balanced to within $1^3/_4$ lb at the rim. Each of the ten spacers between the wheels weighs more than five tons.

The rotor will be supported on shafting weighing 25 tons on one end and 70 tons on the other and designed to take a million-pound thrust. The supporting housings are even heavier—one weighs 374,000 lb and is the largest unit ever machined in the Newport News Shops.

Since the compressor parts were too large for shipment by rail, the "Marine Fiddler," a C-4-type vessel of the Military Sea Transportation Service was chosen to do the job. This ship is one of the few in the world with hatch openings large enough to accommodate the huge compressor parts. Its cargo booms capable of lifting up to 150 tons are also among the largest on any ship.

The Ames tunnel is one of three large unit plan supersonic wind tunnels being built by the NACA. The plan provides for their use by private industry.



One of the eleven 50,000-lb rotor discs making up the eleven-stage, 1,300-ton axial-flow compressor built by the Newport News Shipbuilding Co. is being precision balanced to within $1^3/_4$ lb at the rim in the large view. To the right of this unit, the other ten forged discs have been stacked to check their alignment. Upon installation of blades in the rim slots and attachment of shafting, this will be the 420-ton rotating section of the compressor. The unit will be installed in the huge wind tunnel at the Ames Aeronautical Laboratory shown in the small view.

Puerto Ordaz Ore-Handling System Now in Operation

Rotary railroad car dumper (at left) can dump 67 railroad cars of iron ore in 1 hour. Time cycle of only 53 sec is required to feed a car from the barney pit into the dumper, rotate it, spill a 90-ton load, right the car, and discharge it from the dumper.

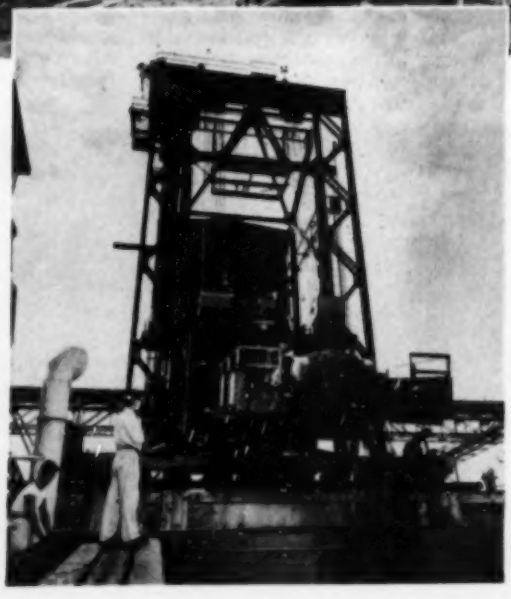
On January 9 the president of Venezuela, Col. Marcos Perez Jiminez, pressed a button at Puerto Ordaz, that sent a stream of rich iron ore along a system of belt conveyors and into the hold of a freighter for shipment to the United States. The scene climaxed seven years of planning by the Orinoco Mining Co., a subsidiary of the U.S. Steel Corp., sparked by the discovery in April 1947 of a large deposit of iron ore on Cerro Bolivar.

Puerto Ordaz, at the confluence of the Orinoco and Caroni rivers, was transformed in two years from a jungle into a 6,000-ton-per-hour ore storage and loading station (December 1953 issue, page 45). It is estimated that at least 2,000,000 tons of ore will be mined and shipped in 1954, and a goal of 10,000,000 tons within the next few years is foreseen.

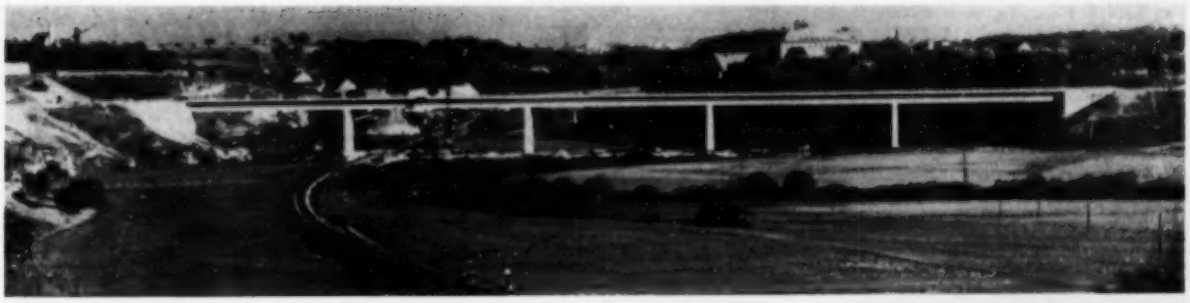
The ore-handling system at Puerto Ordaz, furnished by the Link-Belt Co. as prime contractor, includes facilities for dumping 67 railroad cars an hour, crushing the ore in primary and secondary crushers to minus 5-in. size, and transporting it to a 470,000-ton-capacity storage pile, where it is stocked out by means of a self-propelled, 400-ft-span belt conveyor bridge. The continuous sampling system takes 60 tons of ore off the belt each hour and, after grinding and quartering, retains a representative 5-lb sample from each hour's run. The overage is returned to the conveyor system. One man in the shiploader operating cab controls the speed and capacity of the entire reclaiming system, from storage pile to ship by means of a variable voltage electrical hookup. This arrangement provides speed variations for trimming ship and reduces the cumulative delay resulting from starting and stopping the various units in sequence.

The entire system, developed by the Link-Belt Co. in cooperation with Orinoco Mining Co. engineers, was engineered, fabricated, and installed in about 23 months—well ahead of schedule. Subcontractors on the project were the McDowell Co., S.A., of Caracas, which handled the erection, and the Wellman Engineering Co., which built the car dumper, belt conveyor bridge and shiploader. International General Electric Co. furnished the electrical controls, and the Allis-Chalmers Manufacturing Co., the crushers. The photos were made for the Link-Belt Co. by M. Hans Zielke, of Milwaukee.

Traveling belt conveyor bridge (shown at right) has a span of 400 ft, making it one of the largest units of the kind ever built. Incoming ore travels along the 60-in.-wide belt conveyor in foreground, parallel to the pile, which delivers to the bridge belt conveyor by means of a high tripper propelled by the bridge through a draw bar. A second tripper, on the bridge belt conveyor, discharges the ore onto the pile.



Iron ore is reclaimed from storage at Puerto Ordaz (lower view) at the rate of 6,000 tons per hour by means of four rotary plow feeders, which travel back and forth beneath the storage pile in two parallel tunnels. Each feeder consists of two sets of rotors, each with six rotating bladed arms, mounted on a self-propelled, track-mounted carriage. Photo at right shows rich ore from Cerro Bolivar pouring into a ship at Puerto Ordaz at the rate of 100 tons per min. The shiploader, which travels on rails, can be positioned at any point along the 630-ft deck, and is built to load vessels of any size at any time of year, regardless of an annual 39-ft rise and fall in river level.



Recently opened prestressed-concrete bridge, spanning the Danube Valley in south Germany, is made up of five of the longest continuous prestressed concrete spans ever built. Total length of the bridge is 1,230 ft. Photo at right shows underside of structure.

Long Prestressed Concrete Bridge Spans Danube Valley

The new Danube Valley Bridge near Ulm, in south Germany, completed in October 1953, is one of the longest continuous-span prestressed-concrete bridges in the world. With a total length of 1,230 ft, the structure is made up of five of the longest continuous, prestressed-concrete spans ever built—three middle spans of 230 ft each and 204-ft end spans. It was built in two sections, each consisting of two T-shaped girders, with the prestressed road deck transversely forming the top flange. One section, continuous over two spans, was finished first, after which the three-span section was completed.

Continuity of girders is preserved by a unique system of lapping the cables of the two sections where they meet. The cables, consisting of continuous steel strands inserted in casings in the girder webs, were wrapped around the ends of the girder in each section of the bridge.

Tensioning of the prestressing cables was accomplished in one operation for each of the two bridge sections. In the two-span section, the prestressing cables were looped around the full length of the two spans. At the abutment end of this section, the cable passes around a semicircular concrete block, which stands on rollers and was poured independently of the first span.

Hydraulic jacks were placed in the space between the semicircular block and the end of the first span. Within two days after the section was concreted, an initial prestressing force (equal to about 10 per cent of the total 4,400-ton force) was applied to minimize the development of shrinkage cracks. When the concrete reached the right strength for transfer of the full prestressing force, the block was jacked away from the section, thereby tensioning the whole two-span loop of prestressing cable.

When the jacking operation had imparted the required elongation in the prestressing cable, the space between the stressing block and the first span was concreted. The same technique was then used for tensioning the prestressing cable loop for the three-span bridge section.

In other structures such as the continuous five-span bridge at Neckargartach, Germany (CIVIL ENGINEERING for January 1953), the whole structure (748 ft) was prestressed in one operation at one abutment only.

On the present project, the transverse ribs under the road deck were prestressed singly. Cables for the road-deck ribs are made of two layers of 12 wires, each $^{5}/_{16}$ in. in dia. Comb spacers are used between the 12-wire layers of the cable to ease friction as much as possible, just as for the main girder cables. The design called for 0.084 cu yd of concrete, 6.81 lb of prestressing steel, and 8.2 lb of mild reinforcing steel per square foot of roadway.

The bridge was designed by Fritz Leonhardt, M. ASCE, consulting engineer of Stuttgart, for the German Road Construction Authorities of the State of Baden-Wurttemberg, and erected by the construction firm of Karl Kuebler, Stuttgart. Dr. Leonhardt is a special consultant to Preload Engineers, Inc., of Arlington, Va.

Nuclear Notes

II—Tracer Applications

"Nuclear Notes" are prepared for the Sanitary Engineering Division by its Committee on Sanitary Engineering Aspects of Nuclear Energy, which is headed by Conrad P. Straub, of the Oak Ridge National Laboratory, and includes S. T. Barker, A. E. Gorman, Prof. Warren J. Kaufman, and James G. Terrill, Jr. Questions or answers from the membership with regard to the various problems relating to the application of atomic energy will be welcome. Next month's subject will be: "Structure of the Atom."

Can soil moisture and density be measured in place without disturbing the surrounding material? The answer is yes. Through the stimulation of rapid advances in nuclear science, instruments have been developed which will permit such measurements to be made. Such instrumentation employs the scattering of neutrons and gamma rays. (These terms will be defined and discussed in subsequent columns.) By means of such techniques, it has been reported that moisture contents of ±1 lb of water per cu ft and soil densities to ±5 lb per cu ft have been measured.

Applications of tracer techniques can be shown by the following specific examples. Studies have been described in which cobalt-60 was mixed with wax compounds, spread on floors or other surfaces, and measurements made to determine the wearability of these coatings. Readings taken with radio-sensitive instruments after various periods of use give an indication of how long surfaces last under a variety of conditions. Similar studies have been made on lubricating materials to measure friction between surfaces such as piston rings and cylinder walls.

The petroleum industry has made a novel application of the radioisotope tracer technique to study the movements of different petroleum products in pipelines. In this instance a radioactive tracer is added at the interface between two different materials, and measurements are made along the pipeline to determine the position of the interface. At the refinery the measurement of the presence of radioactive material can be made to operate valves which will route the various materials contained in the pipeline to specific processing points within the plant. More extensive studies are under

way to define the degree of mixing or diffusion that takes place at the interface, the effect of pumping, etc. Flow of liquids in pipes, basins, and in open reservoirs has been determined through the use of radioactive monitoring techniques. Several studies have been reported describing such techniques for the determination of detention times in basins.

The paper, textile, and other industries have used thickness gauges employing specific radioactive sources to control their products. Perhaps similar applications can be developed to measure minute deflections in structures or structural members, since reports indicate that a sensitivity of 10^{-6} in. is possible by this method.

Efficiency of mixing, whether of a liquid, solid, or gas, could be evaluated by use of suitable tracer techniques. For example, by means of suitable radiographic techniques the distribution of cement, water, and other aggregates in any mixture of concrete can be determined. Another application of high-energy gamma rays, such as those from cobalt-60, would be in the detection of flaws in various structural materials including steel and concrete. These would replace X-ray techniques for such purposes. Defects and flaws could be easily detected because air has different transmitting properties than the material under test.

The transportation engineer can develop, through the use of appropriate radioisotopes, methods that will aid him in a study of some of his problems. Some possible applications were pointed out in the first article of this series (May issue, page 93).

With these few selected examples to show possible applications of nuclear energy to the civil engineering field we shall proceed to a simplified discussion of nuclear phenomenon. A knowledge of the fundamentals is rather essential to an understanding of the applications and to originality in thinking up new applications.

New Canadian Projects Spotlighted at EIC Annual Meeting

New engineering projects under construction or recently placed in operation in Canada are of such size and such diversity they must inevitably change the way of life of the Dominion. That at least is the impression gained from attendance at the 68th annual meeting of the Engineering Institute of Canada, where a number of significant developments were discussed on the three-day technical program.

In a paper on "Location and Construction of the Quebec North Shore and Labrador Railway," B. M. Monaghan, assistant chief engineer for the line, said that the Iron Ore Company of Canada's 360 mile railway in Labrador, which will commence operation in August, will haul 1,500,000 tons of iron ore in 1954 and by 1956 will have an annual capacity of 10,000,000 tons of ore. Building the Iron Ore Company's 12,000-hp hydropower development at Menihek, Labrador, "relied upon an airlift operation carried out on a scale never before attempted in Canada," L. A. Carey, resident engineer of the Montreal Engineering Co., Ltd., said in another paper. "Except for a comparatively small tonnage hauled on tractor-drawn sleds, the job was wholly supplied by air transport," Mr. Carey said. "More than 9,000 tons of cement were flown in. Aircraft were on the ground less than 10 minutes on turn-arounds."

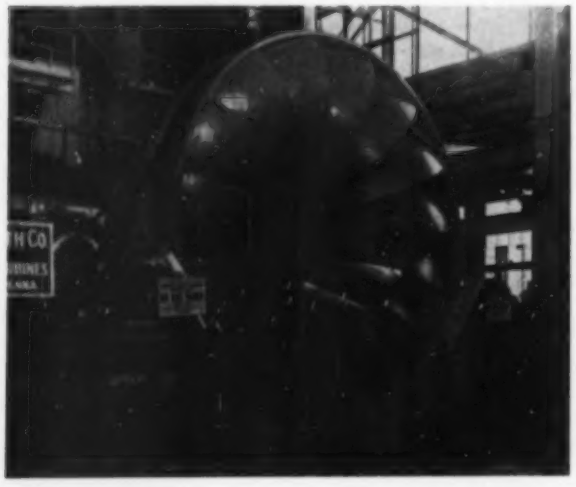
Among other projects described were the recently opened Toronto subway, the first in Canada, which was the subject of papers by W. H. Patterson, J. Y. Doran, and J. G. Inglis, respectively chief engineer, electrical engineer, and assistant manager of equipment for the Toronto Transit Commission.

A 1,500,000-barrel cement plant, under construction near Quebec, was described by Bernard Ulrich, general manager of the St. Lawrence Cement Co., Ltd., which will operate the plant. "The merging of European and Canadian methods is resulting in a plant which differs in many respects from current standard Canadian practice." Mr. Ulrich stated. "Dust production, for example, will amount to 50,000 tons a year in the plant, or enough to cover a circle one mile in diameter with 4 in. of dust.... The plant will, therefore, be equipped with an electrostatic precipitator, with a guaranteed dust recovery of 99 percent." Material handling, he said, "is being cut to a minimum in the plant by locating the cement silos on top of the packing house so that cement can be mixed and conveyed under gravity, at about two-thirds of the usual operating cost."

With the completion, in 1956, of its Sir Adam Beck-Niagara Generating Station No. 2, the Ontario Hydroelectric Power Commission will have increased its dependable peak capacity by 6,345,000 hp since 1945, at a cost of $1,500,000," R. L. Hearn, general manager and chief engineer of the Commission, said in a paper describing this major project. Also of interest in the hydroelectric power field are the two power houses for recently completed plants on the Peribonka River, the first of their kind ever built. Described by R. E. Heartz, president of the Shawinigan Engineering Co., Ltd., the powerhouses are of the semi-open type, with a roof at the level of the top of the generators. An outdoor gantry crane removes the aluminum generator covers, permitting the generators to be dismantled and transferred to a covered repair bay when necessary. "Besides being the most economical type where many units are installed, "Mr. Heartz said, "this method speeds up the construction schedule. . . ."

At the annual banquet D. M. Stephens, of Winnipeg, was installed as president, succeeding Ross L. Dobbin. New vice-presidents are B. C. Ballard, of Ottawa; J. O. Martineau, of Quebec; and N. B. Eagles, of Moncton, N. B. Lewis L. Sillcox, M. ASCE and current president of the ASME, was awarded honorary membership in the Institute. The Duggan Medal and Prize, presented annually for the best paper dealing with the use of metals for structural and mechanical purposes, went to Leo Schenker, A.M. ASCE, research associate for the University of Michigan.

Huge Turbine to Increase Capacity of Niagara-Mohawk System

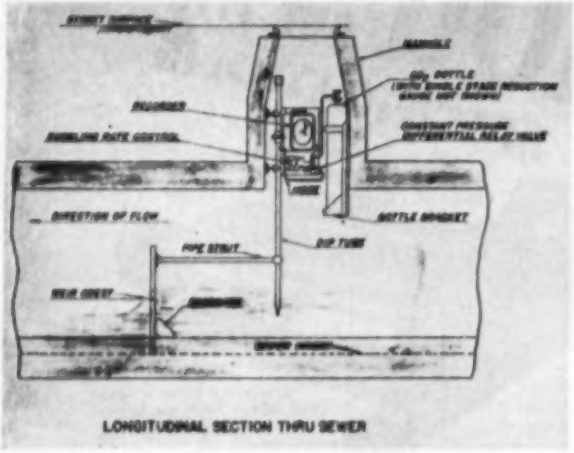


Francis runner leaves manufacturing plant of the S. Morgan Smith Company at York, Pa., for the South Colton Station of the Niagara Mohawk Power Corp. Station is the first of five being built on the Racquette River in northern New York near Potsdam. Completed, the turbine will produce 25,400 hp at 120 rpm under 82.7-ft net head. Rail car was specially built for transporting large equipment.

AEC Contract to Expand Idaho Reactor Testing Station

The Arrington Construction Co., of Idaho Falls, Idaho, has been awarded a $2,021,200 low-bid contract for second-phase construction of ground-testing facilities for a prototype aircraft propulsion reactor at the National Reactor Testing Station in Idaho, according to an announcement from the Idaho Operations Office of the Atomic Energy Commission. The contract covers construction of a control and equipment building, unit substation, test building, fuel transfer pumphouse, and tank building.

Device Measures Dry-Weather Sewage Flow



LONGITUDINAL SECTION THRU SEWER

New instrument reduces labor costs, hazards, and time required for measuring dry-weather sewage flow. Basic parts of instrument, designed by General Industries, Inc., Philadelphia, Pa., are tank for CO_2 gas, recorder, and dip tube that is inserted in dam impounding water from sewage flow. Rate at which gas escapes from tube varies with water level, and changes are recorded by stylus and registered on calibrated chart.

Rolled Wire Fabric Used On Asphaltic Concrete Job

A new technique of reinforcing asphaltic concrete by using welded wire fabric in rolls rather than in sheets, was pioneered by the Texas Highway Department's Beaumont District in the resurfacing early this year of a five-mile stretch of U. S. 69-96 between Beaumont and Port Arthur. Except for test installation, previous use of rolls of fabric for reinforcing bituminous resurfacing had not been successful, especially over long stretches.

The procedure consisted of first widening to 24 ft the existing 20-ft portland cement concrete pavement, which had cracks and open joints. A leveling course, consisting of 100-lb per sq yd, Texas Type E sheet asphalt, was laid across the entire width to a depth of about an inch. The fabric, 6 × 6-10/10 was laid directly on the leveling course which was tack-coated and (using an Adnum finisher) covered with three courses of hot-mix, Texas Type D, totaling 290 lb per sq yd and averaging 3 in. in thickness. Tack coating was used between each course of the hot mix.

The fabric was unrolled its entire length and straightened out on the pavement by a job-rigged "tensioning device" consisting essentially of three lengths of chain and a 9-ft length of pipe, assembled to form a bisected triangle. Use of steel plates, sleds, or hold-down devices normally used with paving machines were found unnecessary.

N. G. Neare's COLUMN

R. ROBINSON ROWE, M. ASCE

The final report of the 7th Annual Convention of the Engineers Club of Esseyeville is the summary saga of a satisfying sell-out, for breakfasts and banquet, lectures and luncheons, party and picnic, while the Speakers Club and Student Chapters stole the show. The whole report is a bit stuffy, but the following abstracts are of passing interest.

Registration (p. 161): Joe Kerr and 6 Cal Klaters arrived on April 29.

Transportation (p. 238): Advance estimates for the Dam Tour on May 1 had been based on the following presumptions, expressed in terms of the respective numbers of visiting members (m), ladies (w), students (s), buses (b) and passengers (p) per bus:

$$m = 2w - 1 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$s = .77w + {}^1/_2 \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$p = {}^1/_4w + {}^1/_2 \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

$$bp = m + w + s + 727 \quad . \quad . \quad (4)$$

Complaints (p. 36): Joe Kerr complained that bus requirement was indeterminate, demanding a fifth equation because of the 5 unknowns. Advised him there were ${}^1/_2$-pints and ${}^1/_2$-wits but no ${}^1/_2$-ladies.

Dam Tour (p. 72): Cal Klater, claiming the free ride offered the first visitor who solved Eqs. (1) to (4) for b, showed that the 4 simultaneous diophantines could be reduced to

$$25b(w + 2) = 377w + 72650 \quad . \quad . \quad (5)$$

Then, observing from (2) that ladies must come in harems of 50 and from (3) that they couldn't come in foursomes, he substituted $w = 50(2u + 1)$ and obtained

$$b(25u + 13) = 377u + 915 \quad . \quad . \quad (6)$$

for which the only solution in positive integers was $u = 1$, $b = 34$. Gave him ticket and he gave it to Papa.

Appendix H (p. 321): The other solution to Eq. (6) is $u = -360$, $b = 15$; with -8987 passengers in each bus, the dam tour would have been indescribably negative.

Banquet (p. 27): Among the 4 couples and 3 stags at the head table, the President and I were end men. The rest of 204 members and 167 wives were seated with 9 or 10 at each of 37 tables, none of which had more than 2 stags. These tables were oval, with a host couple presiding at each, Mamma at one end and Papa at the other. Others were seated so that couples were together and ladies were not.

Prizes (p. 146): At the banquet, Mrs. L drew the silver compote; in a separate drawing for men, Mr. L, next to her but not her husband, drew the fifth of delighter fluid.

Appendix Q (p. 399): This concludes the report. Will take a vacation after asking Joe and Cal what was the chance of unrelated neighbors winning the door prizes.

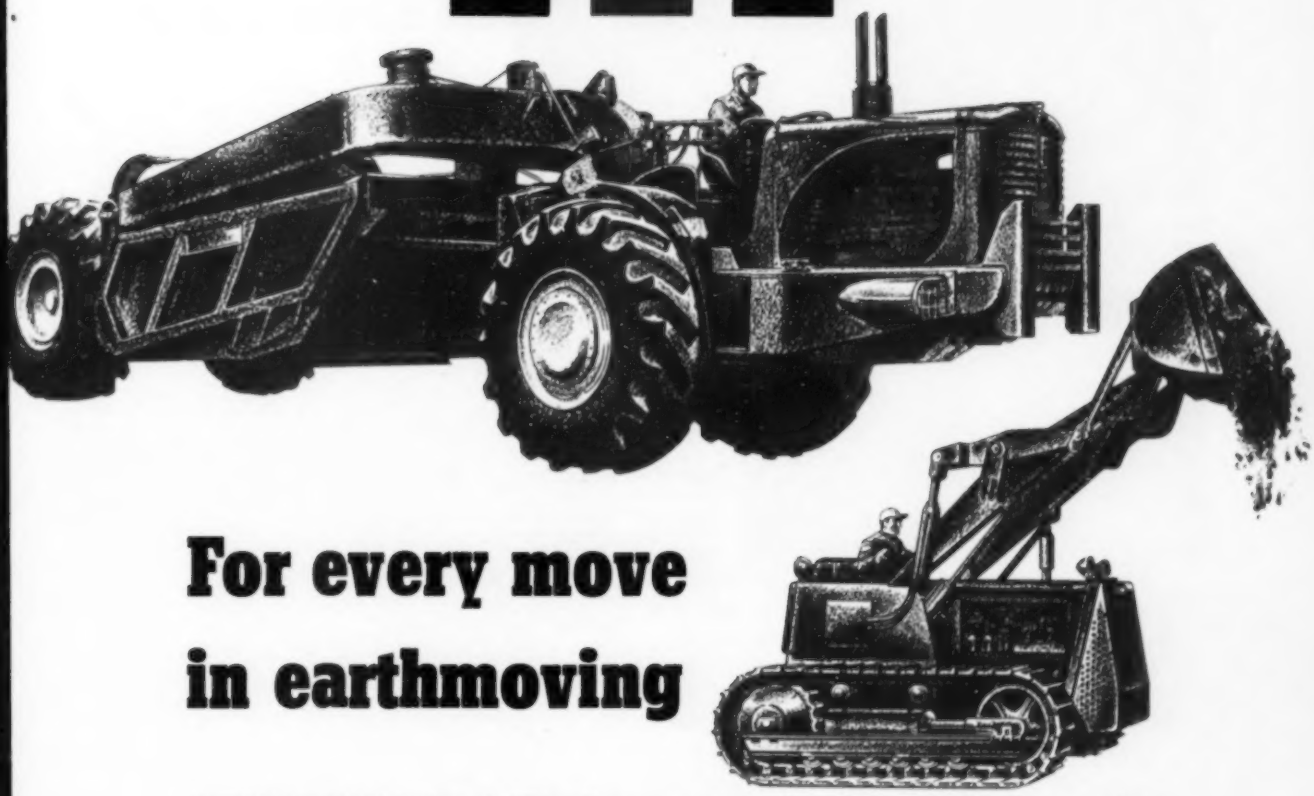
[*Cal Klaters were: Richard Jenney, Flo Ridan* (*Charles G. Edson, who wanted the bus to pick him up in Gainesville*), *Stoop* (*John L.*) *Nagle, S. K. Rueball* (*Keith Jones*), *O'Kay* (*Otto Koch*), *Ed C. Holt Jr., G. I.* (*Morton S.*) *Raff, Sue. R. Rhatt* (*Charles F. Niles Jr.*), *Bernard Gutterman, Jerald N. Christiansen* (*who won the ride*), *and Thatchrite* (*Guy C. Thatcher*).]

New Records Set in N.J. Turnpike Travel

Traffic on the New Jersey Turnpike and vehicular revenues continued to score sharp gains during the first quarter of the year, according to the Commissioners of the Turnpike Authority in their report to bondholders for the quarter. The report also notes further improvement in the safety record of the highway during the period.

A total of 4,746,200 vehicles used the turnpike during the first quarter of the year, an increase of 16.2 percent over the same period in 1953, while revenues from tolls amounted to $3,978,800, an increase of 10.8 percent. Average daily traffic during the period come to 52,730 vehicles, almost twice the engineers' forecast for financing purposes, and considerably more than the daily average of 45,400 during the same quarter of 1953.

Fatalities for the period were at the rate of 2.83 per 100 million miles of travel, a reduction of 28.5 percent over the first quarter of 1953. The commissioners note that the fatality rate is remarkably low—compared with the rate of 7 per 100 million miles for the nation's highways in 1953 and of 6 per 100 million miles on the state's parallel public highways—and not likely to be maintained throughout the year.



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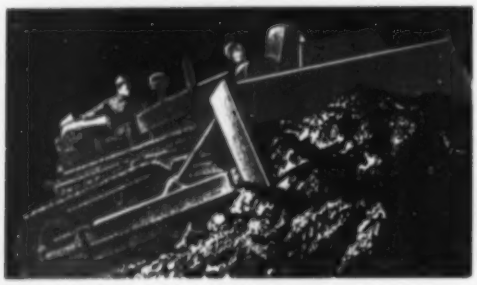
The Champ is

BEST IN THE BORROW PIT. The TD-24 sets record for work accomplished as a push-loader . . . for putting those *heaped* loads in every haul unit . . . for fast maneuvering from scraper to scraper.

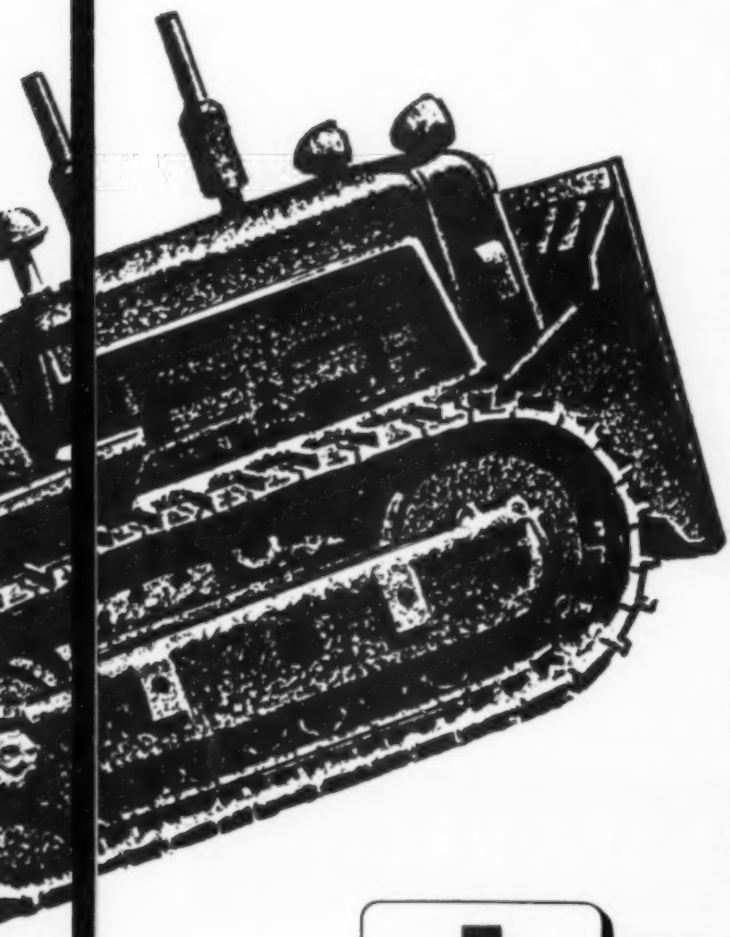


FAST PASS. New TD-24 power—155 drawbar horsepower—pays off on every pass with bigger loads and fast time cycles.

TD-24 with B-250 scraper

Still CHAMP

INTERNATIONAL TD-24 crawler at 155 drawbar horsepower heads a complete equipment line for every move in earthmoving



Now International steps up the power of the most powerful crawler in the world! The TD-24, "The Champ" of crawler power now packs even higher work rating—155 maximum drawbar horsepower.

"The Champ" has been setting performance standards for years with its production-boosting combination of power, speed and stamina. It heads this complete INTERNATIONAL equipment lineup for every move in earthmoving:

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- **Two high-speed, two-wheel, rubber-tired tractors with scrapers (13 and 18-yard heaped capacity).**
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- **Five front-end loaders, for the TD-6 through the TD-18A—tops for speedy break-out and loading of all types of materials.**

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TD-24 crawler with matched scrapers

TD-18A crawler with matched scrapers

TD-24 crawler with BULLGRADER

TD-14A crawler with cable BULLGRADER

TD-9 crawler with hydraulic bulldozer

TD-9 crawler with front-end loader

TD-6 crawler with hydraulic bulldozer

TD-18A crawler with sideboom

Model 2T-75 two-wheel, rubber-tired tractor with 18-yard heaped capacity scraper

Model 2T-75 two-wheel, rubber-tired tractor with 20-yard heaped capacity bottom dump wagon

Model 2T-55 two-wheel, rubber-tired tractor with 13-yard heaped capacity scraper

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DECEASED

Merwin Armstrong (A.M. '17), age 65, retired engineer of Hinsdale, Ill., and an alumnus of Cornell University, died on February 27. From 1921 until 1948 Mr. Armstrong was manager of the manufacturing and clearing departments of the Page Engineering Co., Chicago. Previously he had been with the Clyde Iron Works and the McWilliams Dredging Co. He was a veteran of World War I.

William Taisto Bowers (A.M. '45), age 39, for the past two years senior structural engineer in the Power Division of the Bechtel Corp., San Francisco, Calif., was killed in an automobile accident on January 10. A 1937 graduate of the University of Michigan, Mr. Bowers had been employed as a structural engineer by Whitehead & Kales, River Rouge, Mich.; the A. G. McKee Co., the Fisher Cleveland Aircraft Division, and the Cleveland Electrical Illuminating Co., all of Cleveland; and John Reid, Architects, San Francisco.

Frank William Boyle (A.M. '50), age 32, since 1945 a structural engineer with Combustion Engineering Superheater, Inc., New York, N.Y., died at his home in that city on March 19. Following his graduation from the School of Technology of City College in 1942, Mr. Boyle served in the Army Air Force as a second lieutenant.

John Augustus Bruce (M. '13), age 78, engineer in the Douglas County (Nebraska) Engineer's Office, died at Omaha on April 1. Mr. Bruce was in private practice in Omaha from 1910 to 1930, 1939 to 1941, and 1947 to 1950, intermittently acting as Omaha city engineer; project engineer for the Louisiana Highway Commission and the Nebraska Department of Roads and Irrigation; resident and chief engineer inspector for the Public Works Administration; and engineer with the Corps of Engineers. He was an alumnus of the University of Nebraska.

Alton Ray Collier (A.M. '47), age 56, since 1942 civilian engineer with the Corps of Engineers at Omaha, Nebr., New London, Conn., and Washington, D.C., died on January 31. With the Connecticut State Highway Department from 1919 to 1941, he held the position of superintendent of bridges during most of the period. He recently made his home at Falls Church, Va.

Elbert Lee Cooper (M. '40), age 72, for the past ten years engineer–draftsman with the Department of Public Works, Kansas City, Mo., died there on January 9. From 1912 to 1927 Mr. Cooper was with the highway departments of Missouri, New Mexico, and Harris County, Texas. More recently he had been engaged on water works, sanitary sewer system, and sewage disposal plant projects for several municipalities in Missouri and Florida.

Jesse K. Giesey (M. '20), age 74, who retired in 1953 after ten years as division en-

(*Continued on page 105*)

Deceased

(*Continued from page 102*)

gineer for the Lake Erie Water Project, City of Toledo, Ohio, died in Shrewsbury, Pa., on March 9. Early in his career, Mr. Giesey was connected with Greely & Hansen at Chicago and Rockford, Ill., and Fuller & McClintock at Toledo. He graduated from Rensselaer Polytechnic Institute in 1904.

Thomas Richard Hasley (M. '07), age 89, former city engineer of Menominee, Mich., died there on February 12. From 1889 to 1908 Mr. Hasley was locating engineer for the Wisconsin, Michigan and Copper Range railroads, and from 1908 to 1922 he was engaged on the design and construction of the Grand Rapids Dam and Power Plant, and as valuation engineer for the Missouri Pacific Railroad. He was Menominee city engineer from 1922 to 1938.

Vivian Gregory Kaufman (A.M. '39), age 55, associated with the Corps of Engineers at Vicksburg, Miss., for the past 20 years, died on March 14. Mr. Kaufman had been with the Mississippi River Commission about 13 years and at the time of death was chief of the Flood Fighting Section charged with coordinating flood fight activities within the Lower Mississippi Valley Division. He had also been with the Waterways Experiment Station as a hydraulic engineer. He was a veteran of both wars and a graduate of the University of Illinois.

William States Lee, Jr. (A.M. '30), age 51, of Rancho Sante Fe, Calif., died at La Jolla, on April 6. Following graduation from Princeton University in 1924, Mr. Lee joined his father's firms, the W. S. Lee Engineering Corp., and the Lee Construction Co., Charlotte, N. C., advancing to the presidency in 1934. From 1942 to 1947 he served in the U. S. Navy and in recent years was associated with the Consolidated Vultee Aircraft Co., San Diego.

Albert Howard McQuiston (A.M. '52), age 46, engaged in structural design for Wilbur Watson Associates, Cleveland, Ohio, since 1948, died on March 29. Earlier he had been associated with John J. Cunning, Mansfield, Ohio; and F. A. Pease Engineering Co., Cleveland Transit System, and the New York, Chicago & St. Louis Railroad Co., Cleveland.

Walter Levi Morse (M. '10), age 79, retired railroad engineer of Buzzards Bay, Mass., died on March 9, while on a trip to Berkeley, Calif. Mr. Morse retired in 1944 after 42 years with the New York Central & Hudson River Railroad. He had held the positions of resident engineer, terminal engineer and special assistant in the offices of the vice-president of operations and the chief engineer. He was also with the New York, New Haven & Hartford Railroad for five years following his graduation from Boston College in 1895.

Fred Burgess Nelson (M. '46), age 79, a retired engineer of Lake Katonah, N. Y., died at his home there on March 28. Mr. Nelson was continuously connected with the New York City Department of Water Supply, Gas and Electricity from 1909 to 1948. Previously he was associated with

(*Continued on page 106*)

Deceased

(*Continued from page 105*)

Edward S. Cole, Columbus (Ohio) consulting engineer and the City of Columbus. He was an alumnus of the Ohio State University.

John Thomas Hall Reynolds (A.M. '44), age 43, design engineer with the Jones-Hettlesater Construction Co., Kansas City, Mo., died on December 7. Mr. Reynolds had been employed by several Kansas City consulting firms, including Black & Veatch, the Fluor Corp., the Stratford Engineering Corp., Ash-Howard-Needles & Tammen, and Harrington & Cortelyou. He was a graduate of Finlay Engineering College.

Harold Ward Richardson (M. '47), age 53, since 1949 editor of *Construction Methods and Equipment*, a McGraw-Hill publication, with headquarters in New York, died at his home in New Providence, N. J., on May 12. Affiliated with McGraw-Hill for 26 years,

Harold W. Richardson

Mr. Richardson had been construction editor and western editor of *Engineering News-Record* and executive editor of *Construction Methods and Equipment*. During World War II, as a technical war correspondent for ENR, he covered the activities of the Army Engineers and Navy Seabees, and also served as a consultant to the Construction Equipment Division of the War Production Board. Before entering the publications field he was a construction engineer and superintendent with the Bates & Rogers Contruction Corp., Chicago. Mr. Richardson was the co-author of *Practical Tunnel Driving* and *Bulldozers Come First*. He was an alumnus of the University of Colorado.

Henry Crawford Rumrill (A.M. '43), age 51, since 1947 project engineer with the Florida State Road Department, Fort Lauderdale, died on November 15. Mr. Rumrill had also been connected with the New Jersey and Pennsylvania highway departments. Other engagements were with M. R. Yerkes, Bryn Mawr, Pa.; the Burket Construction Co., Vineland, N. J.; the Works Progress Administration, Newark, N. J.; and the Pan-American Airways at Brazil and Pennsylvania.

Charles Depew Searle (M. '15), age 81, of New York, N. Y., in retirement since 1939, died on March 27, 1953. For 34 years prior to his retirement, Mr. Searle held the

post of senior assistant division engineer with the New York City Board of Transportation. He was an alumnus of Columbia University, class of 1894.

Paul Theodore Seashore (A.M. '31), age 55, consulting geologist of Carmel, Calif., died on April 13. Connected with the Louisiana Land and Exploration Co., New Orleans, La., from 1927 until his recent retirement, Mr. Seashore advanced from superintendent at Houston, Tex., to vice-president and general manager at New Orleans. Earlier he was engaged in geologic and hydrographic projects for the University of Texas, the Texas State Reclamation Department, the Texas State Board of Water Engineers, and the Humphreys Corp., Houston.

Edward Moses Stayton (M. '07), age 79, retired engineer of Independence, Mo., died on March 2. In the 1894–1916 period Mr. Stayton was division and chief engineer for several Midwestern railroads and then served in World War I as a major in the U.S. Army. From 1920 to 1940 he was street railway commissioner of Kansas City, and consultant on highway work for Clay and Jackson counties, Missouri, and on the Blue River and Gooseneck Creek sewers, Kansas City.

John Max Carey van Hulsteyn (M. '48), age 57, commander, CEC, U. S. Navy, stationed at the Boston Navy Shipyard, died on February 5. A veteran of World War II, Commander van Hulsteyn served at San Juan, Norfolk, New York, and in the South Pacific, from 1940 to 1947, and at Boston since 1951. In the New York municipal service for many years, he had been assistant engineer with the Board of Transportation (1928–1933), the Port of New York Authority (1934–1938), and the Board of Water Supply (1938–1940 and 1947–1951). He was an alumnus of Johns Hopkins University.

Rudolph Warner Van Norden (M. '09), age 78, consulting civil and electrical engineer of San Francisco, Calif., died in that city on March 9. Engaged in private practice since 1906, Mr. Van Norden served as technical adviser on the Hoover Dam; and acted as consultant to the cities of Sacramento, San Francisco, Modesto, the State of California, several irrigation districts, and the Department of the Interior. He was the designer of 30 hydroelectric plants, and a graduate of Stanford University.

Isaac Van Trump (A.M. '24), age 71, director and founder of the Van Trump Testing Laboratory, Chicago, Ill., died on February 8. Prior to organizing the laboratory in 1910, Mr. Van Trump was engaged as a chemist by the Vulcanite Paving and Barber Asphalt Paving companies, Philadelphia, and the New York Testing Co., New York. He graduated as a chemist from the Drexel Institute of Technology in 1902.

Willis Dow Peck Warren (M. '20), age 71, head of the Decatur (Ill.) engineering firm, Warren & Van Praag, Inc., from 1918 until his retirement in 1952, died at his home in Decatur, on April 13. His earlier experience in private practice included three years as a member of the firm, Morse-Warren, Carlinville, Ill., and four years as

(*Continued on page 108*)

Deceased

(*Continued from page 107*)

president of the Warren Engineering Co., Decatur. Mr. Warren graduated from the University of Texas in 1906.

Russell Dutton Welsh (M. '29), age 64, retired engineer of St. Petersburg, Fla., and an alumnus of Cornell University, died on February 14. Mr. Welsh was an associate engineer with the U. S. Bureau of Reclamation at Denver, Colo., from 1930 until his retirement in 1946. Among other firms with which he was connected were the Geo. A. Fuller Co., Durham, N. C.; the Southern Railway, Knoxville, Tenn.; and the Pennsylvania Coal & Coke Co., and Geo. R. Morris, Inc., Baltimore, Md.

Reading Wilkinson (M.'45), age 61, colonel, U. S. Army (retired), died at his home near Georgetown, S. C., in March. A veteran of both World Wars, Colonel Wilkinson had served in the Army Corps of Engineers continuously for 30 years. From 1940 until his retirement in 1947 he was district engineer at Charleston, S. C., and Nashville, Tenn. He studied at the University of North Carlolina and the University of Virginia.

Lewis Fredericks Woodall (A.M. '39), age 49, sales engineer for the Industrial Supply Corp., Tampa, Fla., died on March 13. Following studies at the University of Georgia, Mr. Woodall was employed by the City of Atlanta, Ga., the Corps of Engineers, the Missouri Pacific Railroad, Bruce Terminix Co., and the Georgia State Highway Department. In recent years he had been connected with Johns-Manville at Miami, Fla., and Steel Septic Tanks, Inc., Birmingham, Ala.

New in Education

Practicing engineers interested in latest scientific advances in engineering will be able to "brush up" this summer at the Institute for Advanced Engineering, recently established by the University of Texas. Of civil engineering interest in the curriculum for the first year of the new program is a course in Advanced Experimental Stress Analysis, June 14 through July 2. The fee for the three-week course, which consists of 28 lectures and 14 laboratory periods, is $125. Further details are available from the Institute of Advanced Engineering, Division of Extension, University of Texas, Austin 12, Tex.

Winners of the 1954 student essay contest sponsored by the Ohio Engineering Conference Committee, are William T. Jackman, of Case Institute of Technology, who received the $75 first prize; Richard T. Anderegg, of the University of Cincinnati, $50 second prize; and John D. Coldiron, of Ohio State University, $25 third prize. All

are student chapter members. The subject matter for the essay was "My Opinion of Highway Engineering as a Career." Inaugurated as part of the Conference program last year, the contest is open to all students in their third, fourth, or fifth year of civil engineering in any accredited Ohio college or university, or to Ohio residents attending out-of-state schools.

A short conference on New Developments in Structural Design will be offered at Virginia Polytechnic Institute, August 4, 5 and 6, under the sponsorship of the Department of Applied Mechanics. The program will cover topics embracing the design of structures subjected to impulsive loadings such as those resulting from atomic blasts, the elastic and plastic behavior of the materials and component structural parts, and the elastic and plastic analysis of two and three dimensional structures. Registration will be limited to 100, and the fee will be $20. More detailed information may be obtained from Prof. D. H. Pletta, Applied Mechanics Department, VPI, Blacksburg, Va.

In an effort to correct the problem of freshmen dropping out of the engineering curriculum after one term, the College of Engineering and Division of General Education at New York University will launch an experiment in education when it opens a five-week "pre-engineering" summer session, August 3. The session will be open to high school graduates regardless of whether they intend to enter NYU's College of Engineering. Courses in the 1954 program will include an introduction to engineering drawing, pre-engineering algebra, physics, and seminars to acquaint students with the curriculum, opportunities in engineering, and required aptitudes.

Three grants from the National Science Foundation for support of research at Lehigh University include one of $15,000 for a three-year study of the influence of residual strength on column strength. This program, which is being conducted in the civil engineering department under the direction of Lynn S. Beedle, A.M. ASCE, associate director of the Fritz Engineering Laboratory, was started in 1952 at Lehigh in cooperation with the Pennsylvania Department of Highways and the Column Research Council.

With a $10,000 grant from the Wisconsin Alumni Research Foundation, the University of Wisconsin will take part in a campaign by Midwestern universities for funds for a proposed cosmotron. The other schools involved in preliminary planning for the project and contributing the same amount are the Universities of Illinois, Chicago, Iowa, Michigan, Minnesota, Indiana, and Iowa State College. The plan would bring these institutions together on the basis of an agreement similar to that between the Eastern schools, which established the Brookhaven Laboratory for atomic research. It is estimated that construction of 15-30 billion volt cosmotron would cost between $15 and $30 million. According to physicists, such a cosmotron would permit a deeper exploration of the nature of the atom than is possible with the one-to-five billion volt machines now in existence.

New Publications

Hydraulic Handbook. Hydraulic engineers, and civil engineers generally, will welcome the news that the Army Corps of Engineers' pocket-size handbook of hydraulic tables has been reprinted by the Government Printing Office and is again on sale by the Superintendent of Documents at $2.50 a copy. The 565-page reference includes tables of areas and hydraulic radii of trapezoidal channels, hydraulic jump tables, and tables of the Manning Formula for flow in open channels.

Culvert Hydraulics. Some common causes of inefficient hydraulic performance of culverts are studied in Research Report 15-B of the Highway Research Board. The report, which is entitled *Culvert Hydraulics*, consists of two papers—"Model Studies of Tapered Inlets for Box Culverts" and "Importance of Inlet Design on Culvert Capacity"—and the discussion on them. Copies are $1.05 each, and may be obtained from the Highway Research Board, 2101 Constitution Ave., Washington, D.C.

Alloy Steels. In a publication entitled *Alloy Steels Pay Off*, the Climax Molybdenum Co. indicates the general benefits—greater pay load, lower operating costs, longer life, greater safety, and reduced maintenance—that may result from the replacement of carbon steel with a properly chosen alloy steel. The book does not attempt to show what specific grade of alloy steel should be used for a given part. Free copies are available to persons writing on business letterhead to the Climax Molybdenum Co., 500 Fifth Avenue, New York 36, N.Y.

Highway Financing. Availability of the complete Proceedings of the National Conference on Highway Financing, held in Washington, D.C., in December 1953, is announced by the Chamber of Commerce of the United States. In particular, the conference studied street and Highway needs; excise taxes on gasoline and diesel oil; federal-aid highway programs of the future; federal funds for interstate and primary highway routes; toll roads; and additional highway revenues. Priced at $2 a copy and entitled *A Dynamic Highway Policy for the Future*, the 120-page publication may be obtained from the Chamber of Commerce of the United States, 1615 H Street, N.W., Washington 6, D.C.

Cathodic Protection. A 52-page illustrated catalog and price list covering over 700 individual items used by the corrosion engineer may be obtained from the Cathodic Protection Service, 4601 Stanford St., Houston, Tex. In addition to materials, instruments, ditching machines and pipe-coating materials, there are 14 pages of technical data to assist in determining materials and current requirements in cathodic protection installations.

Sanitary Engineering. Accomplishments in the field of pollution control in the Metropolitan area during the past year are summarized in the 1953 Report of the Interstate Sanitation Commission. The Commission, which consists of the metropolitan areas of New York, New Jersey, and Connecticut, warns that the work remaining to be done in the elimination of raw discharges is huge in volume, representing the flow from a population of about 3,000,000. Since its formation in 1936 the Commission has been responsible for construction of about $200,000,000 in pollution control works in the three states. Inquiries should be addressed to the Interstate Sanitation Commission, 110 William Street, New York 38, N.Y.

Highways. A listing of prices of recent specifications, manuals, and other publications of the American Association of State Highway Officials, may be obtained from the AASHO, 917 National Press Building, Washington 4, D.C.

Fire Protection. Essential information on fire prevention and protection is presented for ready reference in the eleventh edition of the *NFPA Handbook of Fire Protection*. The new edition covers many features not found in the preivous edition. Of special interest to engineers will be extensive new tables on fire-resistance ratings of walls, floors, roofs, and columns as well as recent data on the various types of fire-resistant building construction. The 1656-page publication sells for $10, and inquiries should be sent to the National Fire Protection Association, 60 Batterymarch St., Boston 10, Mass.

ENGINEERING SOCIETIES

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This placement service is available to members of the Four Founder Societies. If placed as a result of these listings, the applicant agrees to pay a fee at rates listed by the service. These rates—established to maintain an efficient non-profit personnel service—are available upon request. The same rule for payment of fees applies to registrants who advertise in these columns. All applications should be addressed to the key numbers indicated and mailed to the New York Office. Please enclose six cents in postage to cover cost of mailing and return of application. A weekly bulletin of engineering positions open is available to members of the cooperating societies at a subscription rate of $3.50 per quarter or $12 per annum, payable in advance.

Men Available

CIVIL ENGINEER; J. M. ASCE; 32; married; veteran; BSCE; 5 years' experience detailing, checking, estimating, designing structural steel. Desires permanent responsible position with fabricator or consultant. Will consider sales. Location preferred, South. C-950.

CIVIL ENGINEER; J. M. ASCE; 23; single; BSCE, ME, MS (June), advanced degrees in structural engineering and soil mechanics. Six months' experience airfields, waterfront structures and dams. Assistant instructor one year. Desires permanent position in any phase soils engineering; domestic or foreign. C-964.

SANITARY ENGINEER; A. M. ASCE; married; 36; BS; registered Professional Engineer, California; 13 years' responsible experience, construction, design water and sewage treatment plants; 4 years' sales engineering, public health and administrative experience. Seeks overseas assignment, Europe, South America. Some knowledge foreign languages. C-965.

CIVIL ENGINEER; J. M. ASCE; 30; married; MSCE; U. S. university; 4 years of graduate study and research in U. S. institutions. Four years' experience in design and construction of roads, buildings, canals and canal structures; currently employed in a large multi-purpose River Valley project in India. Desires teaching position in U. S. or abroad; also work in design and/or construction in India, Pakistan or other Asian countries. C-966.

CIVIL ENGINEER; J. M. ASCE; 26; married; BSCE 1950; 4 years' construction and layout experience with concrete contractor. Experienced in supervision and layout of structures for dams and highways. Desires responsible work in construction or with engineering firm. Foreign assignment preferred but will consider domestic. C-967.

CONSTRUCTION ENGINEER OR SUPERINTENDENT; A. M. ASCE; graduate civil engineer; married; 44; 22 years of varied experience, primarily construction; also experience in investigations, surveys, estimating and design. C-968-876-Chicago.

CIVIL ENGINEER; J. M. ASCE; P. E.; 32; married; 6 years' experience in construction including: 3 miles of reinforced concrete bridge; residential construction: housing project with utilities, streets and buildings; engineer in charge of construction of reinforced concrete and structural steel process buildings with mechanical installations. Desires position with consultant or contractor. Location preferred, Southwest, West or foreign. C-969.

PROJECT ENGINEER, BUILDINGS; M. ASCE; 56; married; New York buildings and U. S. industrial plants, 28 years' experience, administrative executive; experienced in appraisals, maintenance, rehabilitation. Will relocate anywhere in United States. C-970.

PROFESSOR; M. ASCE; 41; married; Ph.D.; registered professional engineer; office, field, research, college and university experience. Interested in teaching structures, highways, soils as associate professor, professor or department head. C-971.

CIVIL ENGINEER; J. M. ASCE; 28; married; 4 years' experience in structural design for building construction; 2 years' as resident engineer. Registered professional engineer. Will relocate within United States; desires permanent office position with engineering or architectural firm. C-972.

GEOTECHNICAL ENGINEER; A.M. ASCE; 30; single; CE, MS in geophysics; non-citizen; 5 years' experience in foundation and hydraulic engineering; site explorations, soil mechanics research; applied geophysics. Seeks temporary employment with exploration or consulting company. C-973-544-A-10-San Francisco.

ADMINISTRATIVE ENGINEER; A.M. ASCE; BSCE, MS in mechanics; 36; registered; 7 years' assistant chief engineer supervising development and testing laboratory with new products division; directs educational engineering sales promotion program; desires position with administrative responsibilities. C-974-877-Chicago.

ENGINEER, civil-architectural; A. M. ASCE; ASCE; 41; registered P.E., New Jersey; 17 years' diversified office and field experience. Design and construction of industrial, refinery and chemical plant structures. Experience includes reports, specifications, estimating, procurement, supervision, inspection. C-975.

Positions Available

STRUCTURAL ENGINEER, about 40, professional civil engineering license in New York State. Must have experience in structural steel fabrication and erection. Salary, $9,000–$10,000 a year. Location, New York State. Y-9644.

ENGINEERS. (a) Sanitary Engineer, graduate, with experience in sanitary, civil or public health engineering. Must be registered engineer, or eligible for registration in Vermont. Will conduct investigations and inspections on such problems as condition of water supplies, treatment of sewage, and extent of stream and lake pollution, etc. Conduct research and surveys on sanitation problems; advise and consult with city and town officials, etc. Salary, $3,354–$5,044 a year depending on training and experience. (b) Industrial Hygiene Engineer, graduate, experienced in the field of industrial hygiene. Must be registered engineer. Will organize and conduct difficult engineering studies and investigations in the field of industrial hygiene and perform related work; make inspections of industrial plants; prepare reports; make recommendations, etc. Salary, $3,354–$5,044 a year depending on training and experience. Location, Vermont. Y-9724.

MINING OR CIVIL ENGINEER, 30–35, with strip and underground mine experience, to make surveys, plan production improvements, etc., under direction of chief engineer. Considerable traveling to properties in West and South. Salary, $8,400–$9,600 a year. Headquarters, Illinois. Y-9782.

CIVIL ENGINEER, 26–30, for estimating and valuation of buildings and structures for fire insurance purposes. Salary, $4,500–$4,800 a year. Location, New York, N. Y. Y-9852.

INSTRUCTOR with BS or MS in civil engineering, to teach plane surveying and mechanics of materials. Opportunity for graduate study. Salary, $3,700–$4,000 for nine months. Location, Southwest. Y-9859.

SAFETY ENGINEER, under 40, civil graduate, with several years' experience on heavy construction work. Salary, $7,800 a year base, plus considerable overtime. Location, Iceland. F-9867.

RESIDENT ENGINEER, civil graduate, with experience in the supervision of rock tunnel for either owner or contractor. Two or three years' work. Salary, $9,000–$9,600 a year. Location southern New England. Y-9881.

ADMINISTRATIVE ENGINEER, civil, mechanical or chemical graduate, with 7 to 15 years' experience in a gas utility field and must be capable of directing engineering activities, as well as evaluating operating methods and results. Salary open. Location, Connecticut. Y-9895.

ENGINEERS experienced in the following fields: airfield design, military camp design, highway thruway design, highway bridges, grade crossing elimination, drainage, sanitation, soil mechanics, particularly in the field, concrete mixes, structures. A combination of these categories desirable. (a) Project Manager. (b) Designers. (c) Assistant Designers. (d) Draftsmen. Salaries open. Location, New York, N. Y. Y-9914.

CIVIL ENGINEERS. (a) Civil Engineer, graduate, with some municipal experience, particularly on streets and sewers. Salary, $4,170–$5,670 a year. (b) Junior Civil Engineer, graduate, with about 1 year's experience in general civil engineering and some knowledge of streets and sewers. Salary, $3,500–$4,100 a year. Must be residents of northern New Jersey. Y-9932.

FIELD ENGINEER, civil graduate, with highway, street and municipal engineering experience for field and office work with contractor. Salary, $5,200–$6,500 a year. Location, Philadelphia, Pa. Y-9954.

CONSTRUCTION SUPERINTENDENT with at least 5 years' job supervision experience for school project. Salary, $9,100 a year. Location, Brooklyn, N. Y. Y-9964.

CIVIL ENGINEER experienced in supervision of triangulation surveys. State education, experience, salary desired. Location, Midwest. Y-9977.

CHIEF ENGINEER, civil, mechanical, electrical or chemical, with at least 5 years' experience in responsible supervisory position and preferably in process industries. Knowledge of pulp mill operations and pumps. Will direct engineering department comprised of 6 section heads and their subordinates, to support maintenance, design of new production machinery; some coordination of feeds and output for a paper manufacturer. Salary, $8,500–$10,000 a year. Employer will negotiate fee. Location, Alabama. Y-9987-C-1847.

ENGINEERS. (a) Research Engineer for work on research problems relating to highway design, construction, operation and maintenance. Current projects related to bituminous pavements, non-destructive testing of concrete, highway traffic, snow removal, etc. Salary, $4,200–$6,000 a year. (b) Research Assistant for work on the project combined with part-time study making it possible to secure an MS degree in 2 years. Salary, $2,400 a year. Location, New England. W-4.

PROMOTIONAL ENGINEER, 30–40, civil engineering graduate, experienced in paving and public works preferred, by long established promotional and educational organization, to be a representative in the central New York State area. Give resume of education, engineering experience and salary requirements. W-11.

CIVIL ENGINEER, registered in Michigan, experienced in land planning and subdivision layout with design of roads, water, sewage and drainage facilities. Should be qualified to prepare specifications and let contracts. Salary open. Location, Michigan. D-9342.

SANITARY ENGINEER, civil or sanitary engineering graduate, with at least 5 years' experience in application or operating experience on sewage treatment equipment. Knowledge of sewage and waste treatment processes and practices. Duties will include application work on sewage and waste treating equipment. Company manufactures pumps. Salary, to $7,500 a year. Employer will negotiate fee. Some traveling. Location, western Chicago suburb. C-1826.

ERECTION SUPERINTENDENT, tanks, to 50, with at least 1 year's experience in the field of erection of steel tanks. Will supervise the erection of steel tanks. Salary, $6,000–$8,400 a year. Employer will negotiate fee. Some traveling. Headquarters, Chicago, Ill. C-1894.

Non-ASCE Meetings

American Institute of Architects. Eighty-sixth convention at the Statler Hotel, Boston, Mass., June 15–19.

American Institute of Electrical Engineers. Summer and Pacific General annual meeting, at the Biltmore Hotel, Los Angeles, Calif., June 21–25.

American Society for Engineering Education. Sixty-second annual meeting at the University of Illinois, Urbana, Ill., June 14–18.

American Society of Heating and Ventilating Engineers. Sixtieth semiannual meeting at the New Ocean House, Swampscott, Mass. (11 miles north of Boston), June 28–30.

American Society for Testing Materials. Fifty-seventh annual meeting and exhibit at the Sherman Hotel, Chicago, Ill., June 13–18.

International Nuclear Engineering Congress. First public meeting at the University of Michigan, June 20–25. For further information write to Prof. Robert R. White, 2028 East Engineering Building, University of Michigan, Ann Arbor, Mich.

Conference on Thin Concrete Shells. Three-day conference at Massachusetts Institute of Technology, June 21–23. Full details may be obtained from the Summer Session Office, Room 7-103, MIT, Cambridge, Mass.

Pan American Highway Congress. Sixth congress at Caracas, Venezuela, July 11–21. Details from the Pan-American Division of the American Road Builders Association, Washington, D.C.

Society of Automotive Engineers. Summer meeting at the Ambassador and Ritz-Carlton hotels, Atlantic City, N.J., June 6–11.

UPADI. The third convention of the Pan American Federation of Engineering Societies (UPADI) will meet at Saõ Paulo, August 2–12. Write to EJC, 29 West 39th St., New York, N.Y., for more detailed information.

World Power Conference. Sectional meeting will be held in Rio de Janeiro, July 25–August 10. Detailed information is available through EJC, 29 West 39th St., New York, N.Y.

Inter-American Association of Sanitary Engineering. Fourth conference will be held in Saõ Paulo, Brazil, July 25–31. Details may be obtained from Engineers Joint Council, 29 West 39th St., New York 18, N.Y.

Waterways Experiment Station. All engineers are invited to the "open-houses" at Vicksburg and Jackson, Miss., June 18–20, in observance of the twenty-fifth anniversary of the Waterways Experiment Station.

Engineering principles reduce accidents . . .

(This article begins on page 51)

(*Continued from page 53*)

controllable. This fact alone should serve as an inducement to develop a sound safety program. It is management's duty to formulate such a program—and to continue to support it.

As a guide to management we have developed an eight-point basic plan, which has been received with considerable favor by our major contractor policyholders. The essential points are:

1. Sustained management support and direction
2. Adequate safety organization
3. Active participation by superintendents and foremen
4. Effective employee education
5. Control of accident hazards by:
   - *a*) Evaluation of construction jobs
   - *b*) Establishment of safe methods and good practices
   - *c*) Safeguarding equipment and machines
   - *d*) Control of exposure to occupational disease
   - *e*) Provision of personal protective devices
6. On-the-job medical program
7. Inspection on construction jobs
8. Investigation of accidents

The high toll of deaths, injuries, and property damage has been publicized over and over again. This should leave no doubt in our minds as to the urgent need for concerted action to reduce this appalling waste. The construction industry invariably pays for this high accident rate through higher insurance costs, and above all, through indirect costs that ultimately must come out of profits.

Construction is an old industry which has played a major part in bringing our country to the leading position it holds in the world today. But its accident record is a challenge to every one of us.

It cannot be improved through hit-or-miss methods.

It cannot be improved by leaving the problem to chance.

What must be done is to establish an intelligent over-all safety program that is accepted and practiced by the entire staff. Above all, it must be an integral part of the engineering knowledge and practice involved.

(This article is based on Mr. Luna's talk at the ASCE Atlanta Convention, before the Construction Division session presided over by Harold W. Hunt, Secretary of the Division's Executive Committee.)

RECENT BOOKS

Heating, Ventilating, Air Conditioning Guide, 1954

Chapters on a wide range of topics are grouped under the following broad headings: fundamentals, human reactions, heating and cooling loads, combustion and consumption of fuels, systems and equipment, special systems, and instruments and codes. Important changes have been made throughout in accord with recent developments, and a chapter on residential summer air conditioning has been added. (American Society of Heating and Ventilating Engineers, 62 Worth St., New York 13, N.Y., Volume 32, 1954. 1616 pp., $10.)

Climate and Architecture

Beginning with an introductory chapter on dwelling type as related to geographical location, the author, Jeffrey Ellis Aronin, devotes separate chapters to detailed analyses of the influence of the sun, temperature, wind, precipitation, and other climatic factors on building design. He reviews the physics of these influences, indicates their beneficial and disadvantageous aspects, and demonstrates how they may be effectively controlled for the best results. Conclusions are based on the latest technical data, and an extensive bibliography is provided. (Reinhold Publishing Corp., 330 West 42nd St., New York 36, N.Y., 1953. 304 pp., $12.50.)

The Collected Papers of Stephen P. Timoshenko

This volume contains most of Professor Timoshenko's important articles contributed to periodicals in French, German, and English. Some handbook articles are excluded, as are book reviews, discussions of papers, and a few articles more technical than scientific. A list of Timoshenko's early Russian articles and a short biographical sketch are included. (McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N.Y., 1953. 642 pp., $15.)

The Cyclotron

An account of the development of the 37-inch cyclotron at Berkeley, first published in 1940. In this new edition, minor textual alterations have been made by the author, W. B. Mann, a chapter has been added covering some of the developments of the last fifteen years, and the bibliography has been brought up to date. (John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., fourth edition, 1953. 118 pp., $2.)

Engineering Steels

The emphasis in this book is on steel from the engineer's point of view: its selection and use for any engineering purpose. The opening chapters deal with processing—melting, casting and hot working, and heat treatment. Then follows material on hardenability and mechanical properties, including testing. Plain-carbon, alloy, cold-worked, tool, and other special steels are dealt with separately, as are such subjects as scrap recovery, corrosion, surface hardening, and machinability. Appendices include a bibliography, British specifications, and other pertinent data. The authors are Leslie Aitchison and William I. Pumphrey. (MacDonald & Evans, Ltd., London, 1953. 923 pp., £ 5.5s.Od.)

Fundamentals of Reservoir Engineering

The aspects of reservoir engineering covered in this book by John C. Calhoun, Jr., are the nature of gases, liquids, and gas-liquid systems; the nature of porous rock systems; concepts of rock-fluid, system behavior in respect to fluid flow, etc.; the behavior of natural rock-fluid systems, including questions of well spacing and fluid injection; data and performance criteria on reservoir operations; and the behavior of individual wells and well systems. The material, originally published in the *Oil and Gas Journal*, has been reorganized but not rewritten. (University of Oklahoma Press, Norman, Okla., revised ed., 1953. 417 pp., $6.)

Route Location and Surveying

The third edition of Professor T. F. Hickerson's book, previously published under the title of *Highway Surveying and Planning*, is of broadened scope, now including chapters on railways, drainage surveys, etc. Special attention is given to the use of maps in preliminary studies and to safety considerations in highway location and design. The 260 pages of tables add to its usefulness as a reference and field manual. (McGraw-Hill Publishing Co., Inc., 330 West 42nd St., New York 36, N.Y. 543 pp., $6.)

Introduction to Aeronautical Dynamics

This comprehensive work by Manfred Rauscher, formerly of M.I.T., now a professor of aircraft structures and design in Switzerland, is designed as a textbook for upper class students. It affords a thorough grounding in the dynamical principles involved in studying airplane motion and stability. Starting with basic chapters on Dynamics of a Particle and Fundamental Equations of Fluid Motion, the book proceeds to consider airfoils, the dynamics of rigid bodies and oscillations of systems with one or more degrees of freedom. Numerous diagrams illustrate the text. Problems with solutions are found at the end of each chapter. (John Wiley & Sons, Inc., New York, N.Y., 664 pp., $12.)

Government Contracts Simplified

This book by Attorney G. W. Lupton, Jr., is a general reference work on government procurement contracts, containing practical information on government agencies and their procurement procedures. Information on bidding, negotiating, contract conditions, performance and financing, based on government manuals and legal principles, is included. Supplements to keep the book up to date are issued monthly. (The Lupton Company, 3801 Connecticut Ave., N.W., Washington, D. C., 596 pp., $10 plus supplements.)

Positions Announced

U. S. Civil Service Commission. Announcement has been made of an unwritten examination for the position of Technologist (Grades GS-7—GS-15) paying $4,205 to $10,800 a year, in Washington, D.C., and nearby areas. For information on education and experience requirements and application forms, write to the U.S. Civil Service Commission, Washington 25, D.C.

Applications for Admission to ASCE, April 17–May 8

Applying for Member

HECTOR EDWIN ERNEST COLE BARNES, Nassau, Bahamas.
LENNON GRAYSON BELL, Coeur d'Alene, Idaho.
JAMES W. BEVERAGE, Knoxville, Tenn.
LAWRENCE NEAL BIGELOW, Gary, Ind.
EDGAR THURSTON BOARDMAN, Carson City, Nev.
KENNETH ROBINETT CALDWELL, City of Harlingen, Tex.
HENRY MARTYN CHANCE, II, Philadelphia, Pa.
BURTON E. CRUMRINE, Savannah, Ga.
CHARLES GARFIELD DECKER, Lubbock, Tex.
DONALD MELICK DITMARS, New York, N.Y.
MENDEL GLICKMAN, Norman, Okla.
IRA PURDY GRIFFEN, Washington, D.C.
EDWARD SCOTT HOPKINS, Baltimore, Md.
ROBERT KEMP HORTON, Cincinnati, Ohio.
SERGE IVAN KOLESOFF, Pasadena, Calif.
HARRY JAMES LARSEN, Norris, Tenn.
ROBERT GILBERT LOVETT, Richmond, Va.
WILLIAM KINGSLEY MCGRATH, New York, N.Y.
JOSEPH EDWARD MCSTEEN, Cleveland, Ohio.
JOHN WILLIAM MEYERS, Philadelphia, Pa.
PAUL LEONARD OSWEILER, Dayton, Ohio.
CHANNING LING PAO, Fairborn, Ohio.
CHRISTIAN FREDERICK PETERSEN, JR., Monrovia, Calif.
JOHN CALVIN POTTS, Martinsburg, W. Va.
WILLIAM DAVEY RITCHIE, JR., Doylestown, Pa.
JOHN BURTIS SAXE, New York, N.Y.
OLIVER JOHN SEMMES, JR., Pensacola, Fla.
KARL OTTON STRENGE, JR., River Edge, N.J.
WALTER PHILIPP THOMPSON, Honolulu, T.H.
THEODORE MARKWALTER VON SPRECKEN, Washington, D.C.

Applying for Associate Member

JAMES CARSON AGNEW, Minneapolis, Minn.
NOLAN BYRD ALLISON, Houston, Tex.
FRANCIS AONA, JR., Honolulu, Hawaii.
HORACE LODEN BELOU, San Lorenzo, Calif.
WILLIAM EMMETT BRADBURY, Lafayette, Calif.
FRED LEO CAROTHERS, Birmingham, Ala.
NICHOLAS CHRYSSAFOPOULOS, Urbana, Ill.
JAMES LAWRENCE CRONIN, JR., St. Louis, Mo.
LAWRENCE CUNHA, JR., Honolulu, Hawaii.
ROBERT OWEN DEAN, Houston, Tex.
ELMO JOSEPH DERICCO, Carson City, Nev.
ALFRED MATHEW ESCHBACH, Fort Belvoir, Va.
MICHAEL YUE ONN FAM, Singapore, Malaya.
VERLE FARROW, Fairfax, Va.
AHMET HUSAMEDDIN GUZ, Ankara, Turkey.
RAGNAR FOSSE HANSEN, Newton, Mass.
HUGH BROCKWAY KING, Lawrence, Kans.
JAMES DAVID KISSELL, Lincoln, Nebr.
LESLIE NELSON KNUTSON, Duluth, Minn.
MATT LEHMANN, Palo Alto, Calif.
ALPHEUS CROSBY LYON, JR., Orono, Me.
SANTIAGO MARCHINI, Milano, Italy.
GEOFFREY MACDONALD NAIRN, JR., Kansas City, Mo.
CHARLES ALVA OLSON, JR., Chicago, Ill.
HOWARD WILLIAM OSBORN, Balboa Heights, Canal Zone.
SALVADOR MONSERRATE PADILLA ESCABI, San Juan, Puerto Rico.
GORDON GRAHAM PEARSON, Cape Town, South Africa.
GEORGE ALFRED PONSFORD, El Paso, Tex.
PETER GEORGE DAWSON SHALLOW, Kuala Lumpur, Malaya.
RALPH LEO SHELTON, Clayton, Mo.
WILLIAM HENRY SHEWAN, Carson City, Nev.
WINCHELL SMITH, Safford, Ariz.
MURRAY J. STOKELY, Gibbstown, N.J.
ALFRED DWIGHT SMYTHE, Honolulu, Hawaii.
ROY ALFRED TAYLOR, Dallas, Tex.
JOHN WALTHAMOR TITUS, Kansas City, Mo.
ALBERT QUON YAU TOM, Honolulu, Hawaii.
PETER HERBERT FREDERICK TRINGHAM, Fort Worth, Tex.
BENJAMIN GARRETT WATKINS, Fayetteville, N. C.
SERGIO RUIZ ZEGERS, Portland, Oreg.

Applying for Junior Member

MARSHALL WILSON AMIS, JR., Fort Worth, Tex.
JAMES FRANK CAMPBELL, Whiting, Ind.
MARIO CAPOGROSSO, New York, N.Y.
LEE ROY CARTER, Kevil, Ky.
CLYDE PROVO CASS, Melbourne, Fla.
BENJAMIN CORNELIUS DOELL, Saskatchewan, Canada.
ROBERT GERARD HELF, Milwaukee, Wis.
CLAVIN EUGENE HOUSTON, Atlanta, Ga.
RICHARD ISA, Curacao, Dutch West Indies.
ROBERT ATWOOD KEEFE, Cambridge, Mass.
BRIAN JOHN LEWIS, Los Angeles, Calif.
HAROLD LOIGMAN, New York, N.Y.
RICHARD LYNCH, Detroit, Mich.
JOHN IRWIN THOMAS MOLONEY, Chicago, Ill.
DONALD HARVEY MOYER, San Francisco, Calif.
PAUL RATNER, Norfolk, Va.
BERNARD MICHAEL SEDLAK, Seattle, Wash.
COLIN GEORGE SMALLRIDGE, Worcester, Mass.
RUSSELL WARFIELD SUBLETTE, Kansas City, Mo.
ARTHUR CANNING TAYLOR, JR., Lexington, Va.
DONALD PIERRE WALKER, Hoquiam, Wash.
CHARLES AUGUST WEGHORN, Williams Bay, Wis.
JAMES ANDERSON WELLS, Coraopolis Pa.
ROBERT HOWARD WHITE, Whiting, Ind.

[Applications for Junior membership from ASCE Student Chapters are not listed.]

QUESTION*

How much more material is there in a Three-Inch-Higher Windrow . . . 9% . . . 18% . . . 31% . . . ?

Cross section of an average, 21-inch high windrow . . . the area (width x height ÷ 2) is 614 sq in.

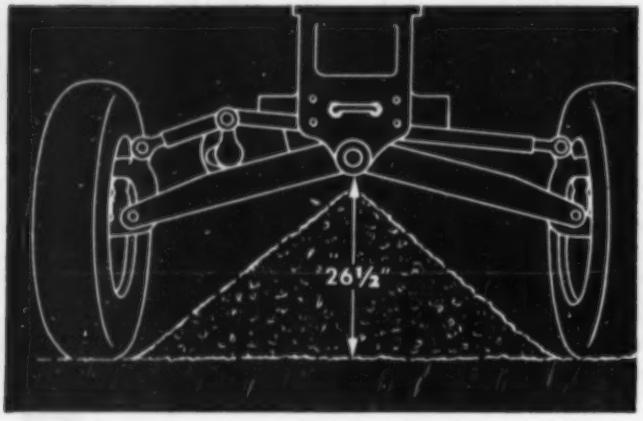
Now increase the height of the windrow by 3 in. The cross-section area now equals 804 sq in.

The difference . . . 190 sq in, over 30 percent more area, which means over 30 *percent more yardage.*

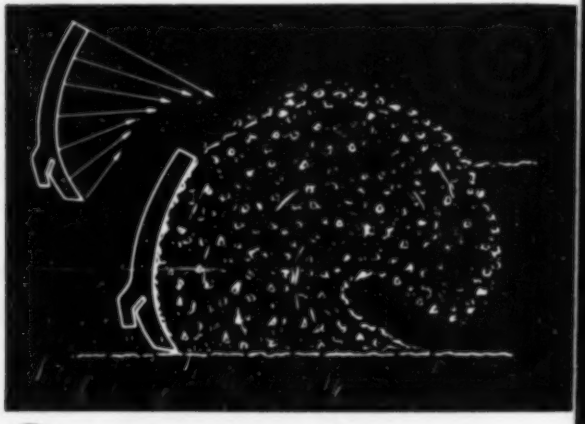
*Only a Combination of Advanced Design Features Lets a Motor Grader Handle Big Loads Fast

To take full advantage of even a *three-inch* difference in windrow height (as explained above) a heavy-duty motor grader needs new design and performance characteristics from front to rear . . . and from the top of the main frame to the bottom of the blade. No single feature can give you the increased work capacity that is so essential on road construction, maintenance and oil-mix jobs.

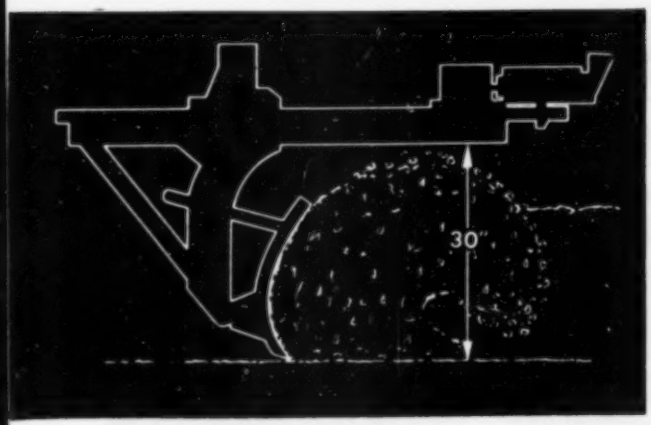
Now let's analyze the Allis-Chalmers 104-brake-horsepower AD-40 to see how it measures up to these stiff requirements.



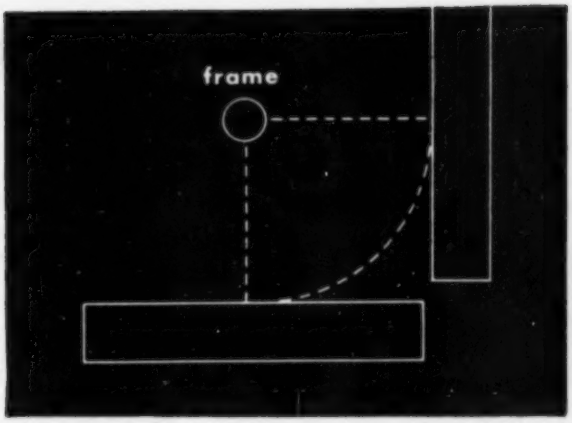
1 **A high-arch front axle** to straddle big windrows . . . take advantage of that 3-inch difference and let big loads pass through to the blade.



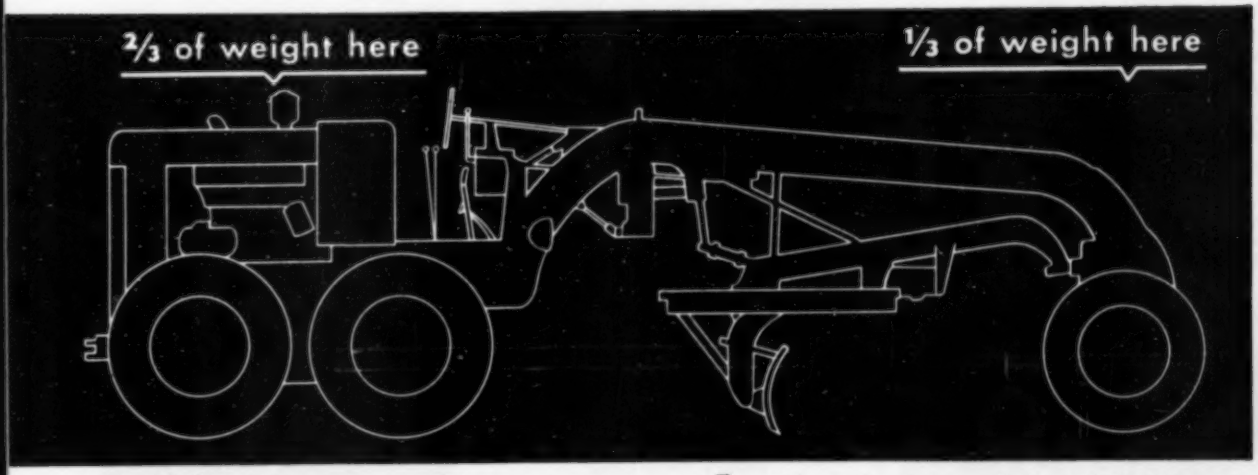
2 **A rolling-action moldboard** . . . to insure a "live" load that rolls freely off the blade . . . moves the load faster and takes full advantage of engine power.



3 **Ample throat clearance** . . . to handle 30 percent bigger loads without disturbing free, rolling action . . . and without jamming dirt, oil-mix or any other material against the circle.

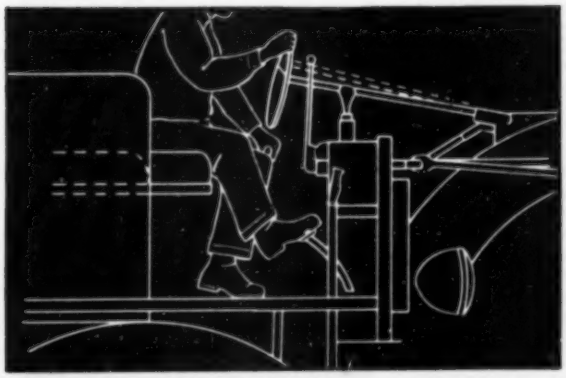


4 **Full blade freedom** . . . the exclusive tubular frame and a long tubular drawbar insure full blading effectiveness on the road, in the ditch or on the slope.



5 **Blading accuracy** is essential. A long wheel base, the tubular frame . . . and lift-cases located directly over the circle, provide smooth, accurate finishing.

6 **Balanced power, weight and traction** . . . a heavy-duty engine and *two-thirds* of the weight concentrated on tandem-drive rear wheels provide the best in traction, positive blade pressure and steer-ability.



7 **Easy control and visibility** — A big platform with plenty of leg room . . . adjustable seat and steering wheel . . . power steering will assure working ease. Single member frame, low control board and tapered platform corners provide "pilot-house" visibility.

This design, that combines working advantages every owner needs and wants, exists in only one motor grader . . . the Allis-Chalmers AD-40. *That's a fact* . . . a fact your Allis-Chalmers dealer will be glad to prove to you. Ask him to show you how the AD-40 gives you the *differences* that mean more work done . . . by a demonstration under on-the-job conditions.

ALLIS-CHALMERS
TRACTOR DIVISION • MILWAUKEE 1, U. S. A.

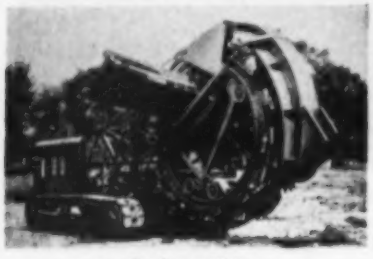
AD-40 Motor Grader
104 brake hp • Weight — 23,000 lb

EQUIPMENT, MATERIALS and METHODS

NEW DEVELOPMENTS OF INTEREST AS REPORTED BY MANUFACTURERS

Ditcher

THE BUCKEYE 315 is a heavy-duty, wheel-type ditcher designed for digging ditches for cross-country pipelines for oil and gas, as well as storm sewers, main sewerage lines and systems, water mains, electric and telephone cables and conduit, and building foundations and footings. It is designed to dig to a maximum depth of 6′ with widths of cut varying from 24 in. to 40 in. in steps of 2 in. The machine has 8 digging speeds forward, from 1.37 to 20.49 ft a min. Independent wheel and crawler speeds make the machine exceptionally flexible, since maximum or minimum speed of either is available with maximum or minimum speed of the other. A heavy-duty diesel engine, 76 hp at 1600 rpm, powers the Buckeye 315; a gas engine, 80 hp at 1600 rpm, is optional. Two types of clutches are available, either Twin Disc fluid coupling in conjunction with over-center type friction clutch, or heavy duty Twin Disc single plate toggle type clutch. Transmissions are fully enclosed and sealed against dirt. All gears are precision cut and run in oil or mesh with gears running in oil. All shafts turn on anti-friction bearings. The heavy-duty digging wheel comes equipped with

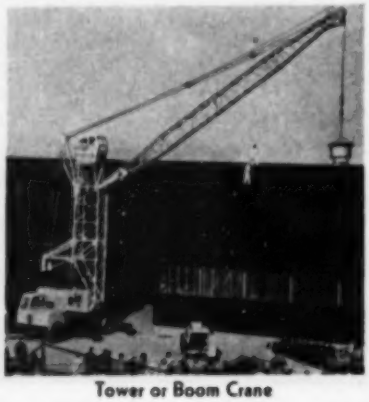


Buckeye 315

15 standard buckets, which are bolted on one piece digging rims with variable bucket spacing. Rims are drilled so that 8, 10, 12, or 15 buckets can be used. Flat bottom buckets are available as optional equipment. All buckets are equipped with long life "Quick Change" rooter bits, which save hours in changing when bits need replacement. Soil can be deposited on either side of the ditch by the shiftable conveyor. There are six conveyor speeds, from 225 to 764 ft a min. Crawlers are exclusive Buckeye heavy duty non-clogging, self-cleaning type which clean themselves even in mucky soil. Wide and long, they maintain low ground bearing pressure of 6 lb per sq in. to permit the machine to operate over soft soil. All controls are grouped within easy reach of the operator, who is provided with a large platform and comfortable seat. Unit-type construction of the machine makes servicing easy. All units are easily accessible and removable for maintenance without disturbing others. **Gar Wood Industries, Inc., CE 6-118, Wayne, Mich.**

Mobile Crane

IN RECENT years progressive contractors have taken advantage of any new equipment to reduce costs and speed up completion of contract, and, in doing so, have taken advantage of the various types of mobile cranes readily available. Coles Cranes, Inc. announce that their associated company in England has designed and produced the first crane in the world which is fully mobile on pneumatic tires, and which is readily convertible from a tower crane to a strut boom crane. This outstanding versatility, it is claimed, may well be the answer to the many problems of handling building components, and will result in the reduction of many precious days on each contract. In addition to the many advantages of the mobile crane, this tower crane has the added ability to raise



Tower or Boom Crane

and lower its own tower, and can travel over long distances from site to site at a fraction of the cost of moving static plant. It can operate as a tower crane at certain stages of the work, and as an ordinary boom crane at other stages, giving the contractor the opportunity to make the fullest use of his plant. It is electrically operated, but generates its own power by means of a gasoline-engine, which makes it independent of trailing cables and power points. The crane, itself, has three main motions, hoist, boom hoist and slew, each operated by a separate electric motor which, in turn, is energized from a specially designed generator coupled to the power unit. This system of transmission instantly provides a smooth, rapid and accurate operation, and a delicate control of loads. The model shown in the photograph is fitted with a 60′ tubular boom which will lift 5 tons at 24′ radius to a height of 82′6″ above ground level. The crane operator is seated 36′ above ground level, a strategic position providing perfect visibility of the full working area. The travel motion can be operated with the tower erected, but for traveling over greater distances or under overhead obstructions, the machine can lower its own tower. **Coles Cranes, Inc., CE 6-118, Joliet, Ill.**

Davis Pit-Bull

LOW-COST VERSATILITY is a notable feature of the new hydraulically-operated Davis Pit-Bull—one basic unit with eleven attachments—now being introduced to the industrial, municipal and heavy construction fields. Fitting all Ford or Ferguson tractors, the new Pit-Bull is available with whatever combination of attachments the buyer has use for. The eleven attachments that fit this basic unit were selected after analyzing the needs of general contractors, municipalities and other users of industrial equipment. The attachments include a $^{5}/_{8}$ cu yd bucket, a back-hoe that digs $10^{1}/_{2}$ ft, a trencher with a digging depth of 5 ft, an 8 ft rotary broom with a 60 deg operating arc for sweeping at angles, a 72 in. dozer blade, a swinging crane, a 45 in. roller with 100 PSI, a rotary mower which pivots 180 deg for side mowing, a lift fork with capacity of 2500 lb, a 350 lb hammer and a 5 ft auger. A cab is available as an accessory for the Pit-Bull which protects the operator from wind, rain and dust. The unit has been designed to give maximum maneuverability, visibility and control. Installation is done by Mid-Western dealers and includes reversing the tractor driver's seat and con-

5/8 Cu Yd Bucket Attachment

trols and putting a Mid-Western syncro-mesh transmission between the clutch and standard transmission. This seating and control arrangement permits the operator to be comfortable and to see exactly where he is working and to maintain finger-tip control over both the tractor and the Pit-Bull at the same time. With the special syncro-mesh transmission, it has four speeds in each direction and the operator can change directions without shifting gears. Twin Hydraulic rear lift arms mounted on the Pit-Bull's superstructure form the remainder of the basic unit. The superstructure carries the weight of the unit without strain on the center of the tractor All of the attachments are hydraulically operated and because they have been designed simultaneously with the basis unit they fit to a close tolerance for easy hook-up. An adequate supply of quick couplers on hydraulic hose connections helps to quicken the changeover from one attachment to another. **Midwestern Industries, Inc., CE 6-118, Wichita, Kan.**

Equipment, Materials & Methods (Continued)

Dump Trailer

A REVOLUTIONARY new bottom dump hauling and spreading trailer, designed to more than double the speed of any spreading operation at a decrease in operating cost, has been developed and placed on the market. This spreader, the Timpte Gilpatrick, embodies many working improvements. It's hauling capacity is from 10 to 12 yd of material, more than double the capacity of conventional dump trucks.

The dumping operation itself, is cab controlled. This means that it actually spreads gravels and other materials "on the run" enabling the spreading operation to proceed at full speed at all times. It eliminates the "extra driver." Another outstanding feature of the "Gilpatrick" is the fact that any idle tractor can be used to pull it. It also features quick turn mobility. **Timpte Brothers, Inc., CE 6-119, Dept. C, 40th & York Sts., Denver, Colo.**

W & T Alticorder

A NEW AUTOMATIC unit which periodically records surveying altimeter readings on 35 mm film is now in production. Known as the W & T Alticorder, it is the first commercial one of its type. It operates continuously and without attention for one week, and eliminates the need for taking altimeter readings manually at base stations. Housed in a light-tight casing, the unit includes a W & T Altimeter, an eight-day clock, a dial-type thermometer for measuring air temperature, a bubble level, and a 35 mm, W & T camera—which can hold a 100 ft spool of 35 mm black and white microfile film. An array of miniature incandescent filament lamps surround the camera lens, and are lighted according to a prescribed schedule—generally at 5 or 10 min intervals by a W & T Flasher Motor Mechanism. The motor mechanism also drives a ventilating fan and advances the film. The purpose of the ventilating fan is to reduce the effect of radiant energy and to draw in as true a sample of outside air as possible. For the sake of simplicity, the camera shutter has been purposely omitted and the film is advanced during the long dark interval between exposures. The unit is powered by one or two 7.5 volt, 40 ampere dry cell packs located outside the housing. **Wallace & Tiernan, CE 6-119, 25 Main Street, Belleville, N. J.**

Equipment, Materials & Methods (Continued)

¾ Yard Shovel

DESIGNED TO meet the increasing requirements of counties, towns, cities and other public works projects, and for the small contracting job, the new Model 250-a ¾ cu yd crawler mounted machine is announced. The operating machinery is mounted on a sturdy one-piece, unit cast steel deck, designed to take the continuous operating strains normal operation gives. The horizontal shafts are held in rigid alignment thru unit cast steel machinery side frames, mounted on machined pads which are integral with the deck. This arrangement prevents weaving and misalignment and reduces the wear and down time of those parts. The swing and travel motions are actuated by spiral bevel gears, machine cut teeth, which operate in oil, and are actuated by large air-cooled band type clutches. Liberal use of anti-friction bearings throughout provide a quiet, and smooth running machine. Shovel

boom is all steel, welded box type construction, 17′ long. Handle is inside type, all steel, welded, 15′ long. Lattice type boom for crane, dragline, and clamshell service is all-welded, with tubular lacings, flange connected. Standard boom length is 35′ with inserts 5, 10, 15 and 20 ft available. Two-piece jibs, 10′ long with 5 and 10 ft inserts are also available. Pin connected boom, which may be folded, is optional equipment. Machine is powered by either gasoline or diesel, Continental engines standard. Overall length of crawlers is 11′ with standard 22 in. width treads, 36 in. width treads are optional equipment. **Osgood-General, CE 6-120, P. O. Box 515, Marion, Ohio.**

Floodlight Projector

NEWEST MODEL F. L. 6, absolutely weather proof, burns 40 hr on six pints of ordinary kerosene or #1 Diesel oil and produces a white light of 5000 C. P. The floodlight is in extensive use by large and small contractors of all types throughout the United States. It is also used by many branches of the armed forces, municipalities, railroads and industrial plants. Mounted on a short 18 in. stand or a 5 to 8 ft telescopic tripod with revolving base, it throws a beam approximately 150 ft by 75 ft. **Wm. W. Lee and Son, CE 6-120, 20 East Jackson Boulevard, Chicago 4, Ill.**

Equipment, Materials & Methods (Continued)

Model 750 Shovel

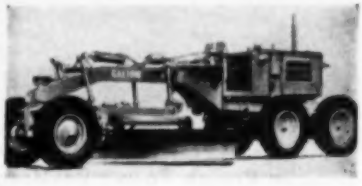
AFTER A FULL two years of research and engineering plus another year of field testing, the new Model 750 Shovel is in full production. The new shovel is rigged for all purpose work; crane, clamshell, dragline, shovel and backhoe. As a shovel, the machine is rated at $1^1/_2$ yd with backhoe designed for the same capacity. Thirty-five tons is the machine's rated capacity as a crane, and it will handle a two yard clamshell or dragline. From tracks to boom tip, the American 750 is a completely new machine. Design features are the result of carefully analyzed field reports on machines in every type operation throughout the nation. Outstanding among the new exclusive features are the single purpose shaft assemblies, each of which can be removed without disturbing another. Swing clutch shaft assembly, retract shaft and crowd shaft assembly are removed from above the machinery deck. Boom hoist drum shaft assembly and boom hoist clutch shaft are removed horizontally from the left side of the machine. A section of the walkway is removed for this

purpose. To further facilitate assembly and disassembly, yet retain maximum strength of the various shafts, multiple tooth involute splines are used. This type spline, of course, eliminates keyways or deep spline which often is the cause of shaft failure. Another labor saving feature is air control on the American 750. It puts power and sensitivity right at the operator's finger tips and lets him retain full feel of the load with a minimum manual effort. American Hoist experience with air control dates back twenty-five years. They have developed, perfected and now use graduated air controls on many of their heavy material handling machines. Clutches on the shovel are of a special contracting band type. The clutches never need be adjusted for the life of the lining since air automatically makes all adjustments. Anti-Friction bearings in the brake linkage of this new machine take a big load off the operator's legs. It is estimated that the combination of anti-friction bearings and American air controlled clutches reduces operating effort as much as 60%. **American Hoist and Derrick Company, CE 6-122, St. Paul 1, Minn.**

Equipment, Materials & Methods (Continued)

Motor Grader

THE GALION Model 450 all-gear tandem Drive Motor Grader is a new model in the medium heavy-duty class. Specifications list the weight, without scarifier, at 20,630 lb and up, depending on extra equipment. It has a 75 hp IHC diesel engine and a new constant mesh transmission, with six overlapping forward speeds ranging from 1.1 to 20.1 mph, and two reverse speeds of 1.3 to 8.4 mph. The tandem drive case on the 450 grader is of exceptionally rugged construction. Positive all-gear four-wheel drive. Gears have three inch faces and are made of heat-



treated nickel alloy steel drop forgings. Two-piece rear axle is full floating design; having a driving function only, it carries none of the grader weight. Large low-pressure tires, size 13:00 × 24, are supplied as standard equipment. Manufacturer states that hand steering with hydraulic booster is also included as standard equipment. All blading and scarifying operations are under full hydraulic control. The grader has a full turn (360 deg) circle reverse, and a 90 deg bank cutting angle. Blade pressure is from 10,950 lb up to 13,150 lb, depending on extra equipment. With standard 12 ft blade, reach outside rear tires is 72″. **The Galion Iron Works & Mfg. Co., CE 6-124, Galion, Ohio.**

Loss-in-Weight Recorder

THE EQUIPMENT for checking and recording the rate of feed of volumetric feeders by the Loss-In-Weight method has been redesigned and improved. This recorder is now available for small as well as large chemical feeders. Applications include: Water treatment (particularly fluoridation), sewage and waste treatment, and any chemical processing operations where records of chemical feeding are desired. The Recorder is compact and extremely simple, with no motors, switches, relays, clutches or electrical parts (except for simple chart movement) to require maintenance. When attached to a volumetric feeder, it does not increase the space requirements of the standard feeder. An indicator scale continuously shows the weight of chemical left in the hopper and indicates when hopper refilling is necessary. Standard 24-hr recorder charts in 50 or 100 lb capacity (for the Omega Model 50 Disc Feeder) records the time of hopper reloading and gives a continuous and exact record of feeding operations. **Omega Machine Co., CE 6-124, 345 Harris Ave., Providence, R. I.**

Literature Available

VALVES—A new data unit no. 234, gives features, application information, and specifications on Jerguson Valves for instrument piping and general use. This four-page booklet contains illustrations and drawings showing how these valves combine unions, nipples, reducers, elbows, tees, valve, and drain valve into one space-saving unit. **Jerguson Gage & Valve Company, CE 6-125, 80 Fellsway, Somerville 45, Mass.**

TIMBER—A booklet on Timber for Military, Commercial and Industrial buildings is offered. Representing the best in commercial and industrial structures built of timber in all parts of the country this bulletin, fully illustrated with "on the job" photographs will be a source of help to architects, engineers and contractors for both military and civilian use. **Timber Engineering Company, CE 6-125, 1319 18th St., Northwest, Washington 6, D. C.**

TRANSMISSION EQUIPMENT—A new 24-page catalog on power transmission equipment is now available. The design and construction of variable speed pulleys, speed belts, V-Belt sheaves, transmission, etc., are fully illustrated with charts and diagrams. **Lovejoy Flexible Coupling Company, CE 6-125, 4982 W. Lake Street, Chicago 44, Ill.**

SUBSOIL INVESTIGATIONS—An 18-page brochure "Subsoil Investigations," has just been released. The purpose of Subsoil investigation, procedures in drilling and sampling, testing in the laboratory, research and engineering consultation are some of the many features discussed. Photographs and charts are included. **Soil Testing Services Inc., CE 6-125, 3521 North Cicero Ave., Chicago, Ill.**

PIPE—A pocket size 16-page booklet, a concrete pipe-laying instruction manual for use on the job has been published. Technical data is boiled down to practical application. Each page carries a separate step in pipe-laying installation, with a large on the job photo and clear but brief explanation. The manual contains data on various sized pipes, and a check list of equipment and supplies needed for the job. **Price Brothers Company, CE 6-125, 1932 East Monument Ave., Dayton 1, Ohio.**

SUMP PUMPS—A new 20-page BJ Sumpmaster Bulletin 54-3-1420, contains all the answers to selecting any of 4000 or more sump pump models. Simply determine desired GPM and total head, then use easy selection charts to find individual model number. Because complete dimensions and outline drawings are included, you can detail pump installation without writing for additional information. A time-saving technical aid for architects, engineers, contractors, equipment dealers or any user of sump pumps. **Byron Jackson Pump Division, CE 6-125 Los Angeles 54, Calif.**

Literature Available (Continued)

ROCK BOLTING—A very informative booklet, Form 4155, on the subject of rock bolting procedures and techniques has been prepared. Intended as a general guide for rock bolting techniques, it describes briefly a complete line of equipment manufactured for this application. It deals with the theory of rock bolting and by means of simple, clear illustrations explains how it works, and also outlines the advantages and disadvantages of the procedure **Ingersoll-Rand Company, CE 6-126, 11 Broadway, New York 4, N. Y.**

WELLPOINT SYSTEM—A new 1954 catalog illustrates and describes the Moretrench Wellpoint System and its use in dewatering various types of construction projects. It also contains "on the job" photographs and technical data. **Moretrench Corporation, CE 6-126, Rockaway, N. J.**

WELDED WIRE FABRIC—A comprehensive report on reinforcing asphaltic concrete with welded wire fabric, has just been released. This booklet is published to answer the many requests due to the interest in this paving process. The major portion of the report gives a detailed discussion of some of the resurfacing projects which involved the use of welded wire fabric as reinforcement for bituminous resurfacing. **Wire Reinforcement Institute Inc., CE 6-126, National Press Building, Washington 4, D. C.**

ROLLING DOORS—A new Bulletin, No. 79, on rolling doors, has just been published. Full of illustrations, charts and technical data, it compares the advantages of the different styles of doors and also gives dimensional information necessary in planning such doors. **The Kinnear Manufacturing Company, CE 6-126, Columbus 16, Ohio**

AUTO-CRETE—A brochure, Auto-Crete, clearly illustrated by photographs, describes step by step how to set-up the machine, how it operates, its advantages and many uses. Specifications are also included. **Auto-Crete, CE 6-126, P. O. Box 1521, Phoenix, Ariz.**

BELTING REPAIRS—A 32-page, illustrated manual that tells how to splice and repair conveyor and elevator belting has just been published. A series of 42 photographs are used to illustrate, step-by-step fashion, proper belt-splicing procedure. The manual describes splicing materials, tools needed, the best conditions for splicing and repair, method of splicing cord and fabric belts and special procedure in splicing rayon belts. A description of vulcanizing equipment and a chart showing quantities of splicing materials needed for any specified job are other features of the manual. Request for copy should be on company letterhead. **The B. F. Goodrich Co., CE 6-126, Akron, Ohio**

PROCEEDINGS AVAILABLE

The following papers have become available as Proceedings-Separates. Following the date of issue of a paper, discussions thereof will be received for a period of three months, as specified on the cover of the paper. Titles will be added to this list every month, as they become available. Technical division sponsorship is indicated by an abbreviation at the end of each item, the symbols referring to: Air Transport (AT), City Planning (CP), Construction (CO), Engineering Mechanics (EM), Highway (HW), Hydraulics (HY), Irrigation and Drainage (IR), Power (PO), Sanitary Engineering (SA), Soil Mechanics and Foundations (SM), Structural (ST), Surveying and Mapping (SU), and Waterways (WW) divisions. Papers issued prior to, and including, Separate No. 289, were not distributed under the present automatic mailing system. If you have not registered in a Technical Division to receive its papers (one Division only) free of charge, please do so promptly by filling out and mailing the enrollment and subscription form (page 129) to Society Headquarters. For ordering separate papers, use the convenient order form on page 128.

Listed in Earlier Issues

355. **Statistical Review of Dam Construction,** by Robert A. Sutherland. (PO)

356. **The Development of the Pulp and Paper Industry in the South,** by A. G. Wakeman. (CO)

357. **A Mathematical Examination of Spiraled Compound Curves,** by T. F. Hickerson. (HW)

358. **Intrusion of Sea Water in Tidal Sections of Fresh Water Streams,** by C. P. Lindner. (HY)

December

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360. **Strength Characteristics of Compacted Clays,** by Gerald A. Leonards. (SM)

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363. **Field Penetration Tests for Selection of Sheepsfoot Rollers,** by S. J. Johnson and W. G. Shockley. (SM)

364. **High Intensity Rainfall and Major Floods in Puerto Rico,** by Miguel A. Quinones. (HY)

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367. Discussions of PROCEEDINGS-SEPARATES 151, 172, 173, and 174. (SU)

368. Discussions of PROCEEDINGS-SEPARATES 148 and 166. (WW)

369. **Unsteady Flow in Open Type Pipe Irrigation Systems,** by E. H. Taylor, A. F. Pillsbury, T. O. Ellis, and G. A. Bekey. (IR)

370. Discussions of PROCEEDINGS-SEPARATES 172, 173, and 174. (AT)

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374. Discussions of PROCEEDINGS-SEPARATES 157, 202, 223, 299, and 300. (EM)

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378. Discussions of PROCEEDINGS-SEPARATES 160, 162, 294, and 308. (PO)

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379. Discussions of PROCEEDINGS-SEPARATES 155 and 215. (SM)

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381. **Open Channels with Nonuniform Discharge,** by Wen Hsiung Li. (HY)

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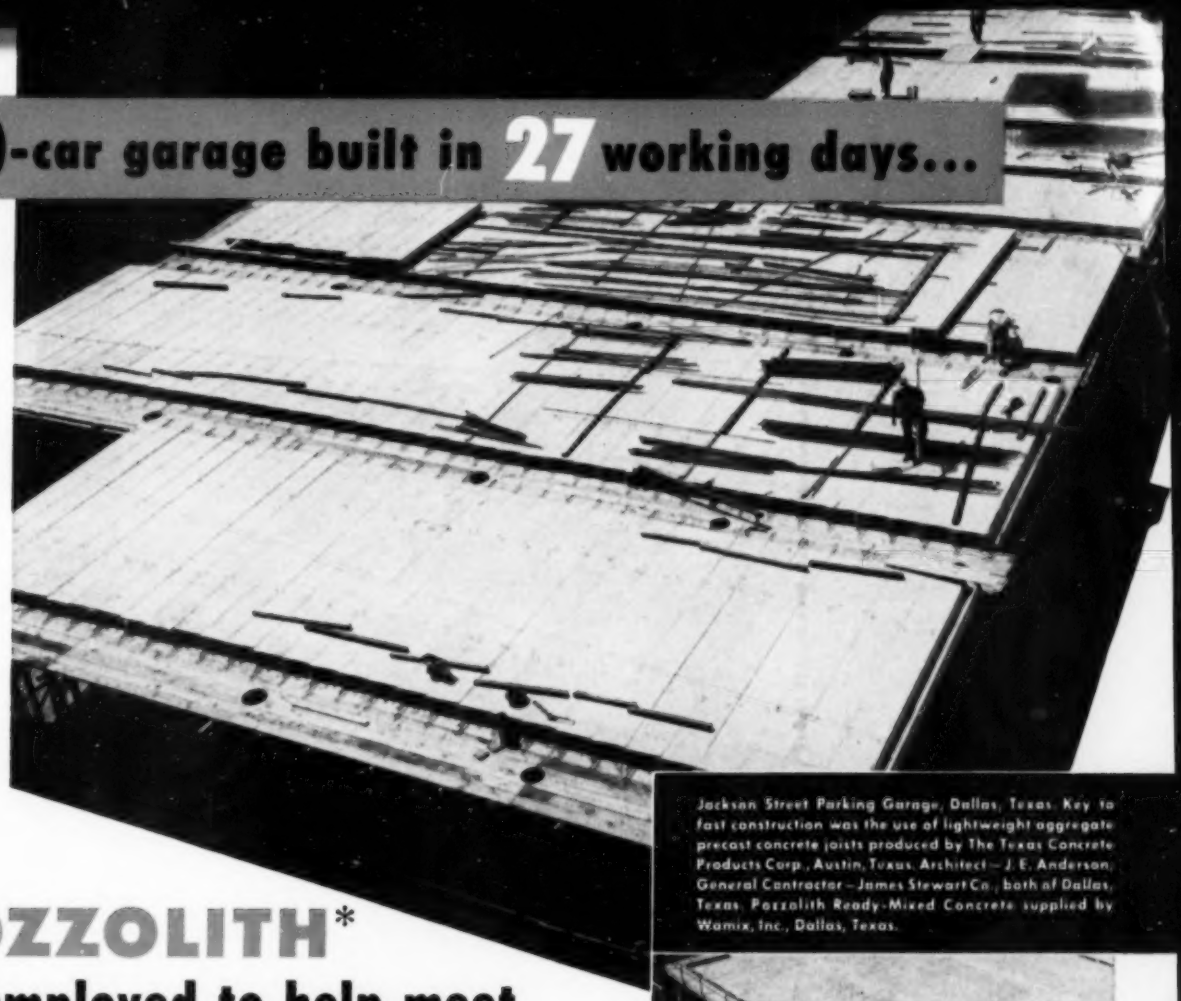

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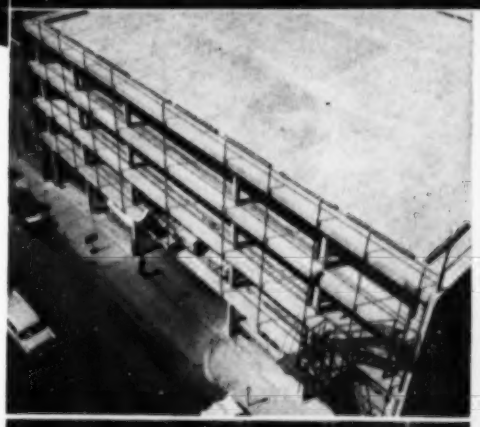

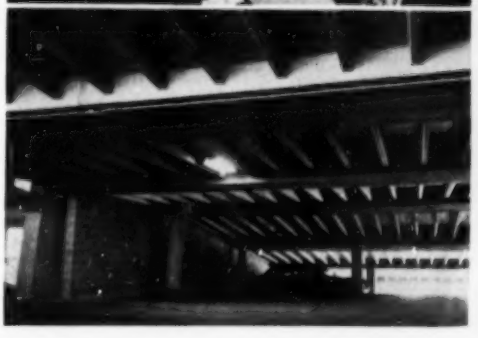

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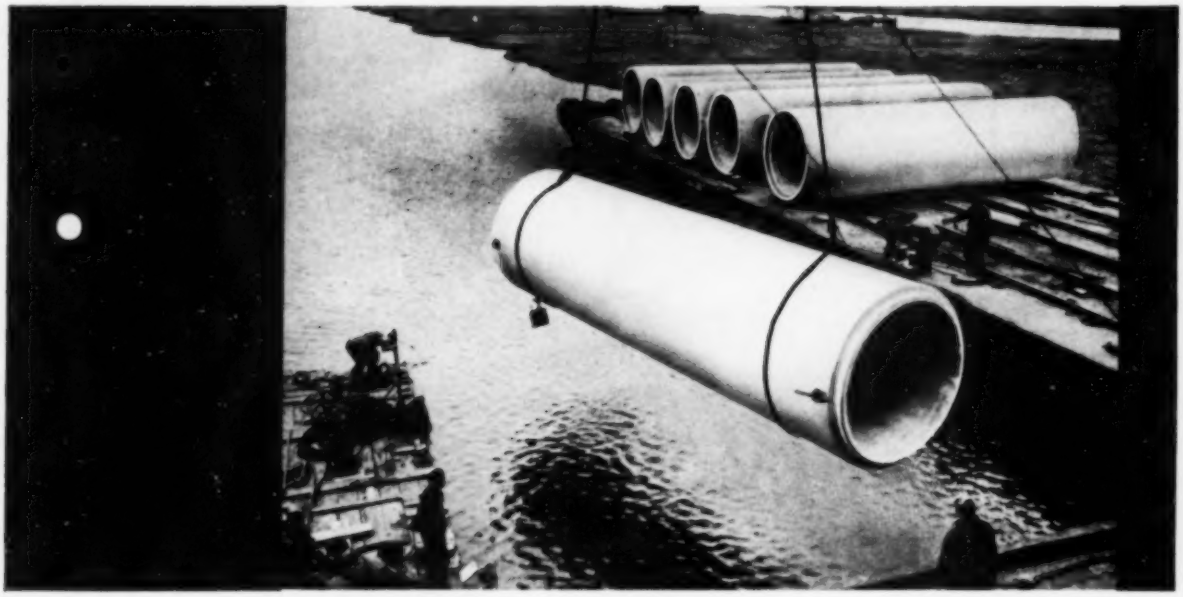

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